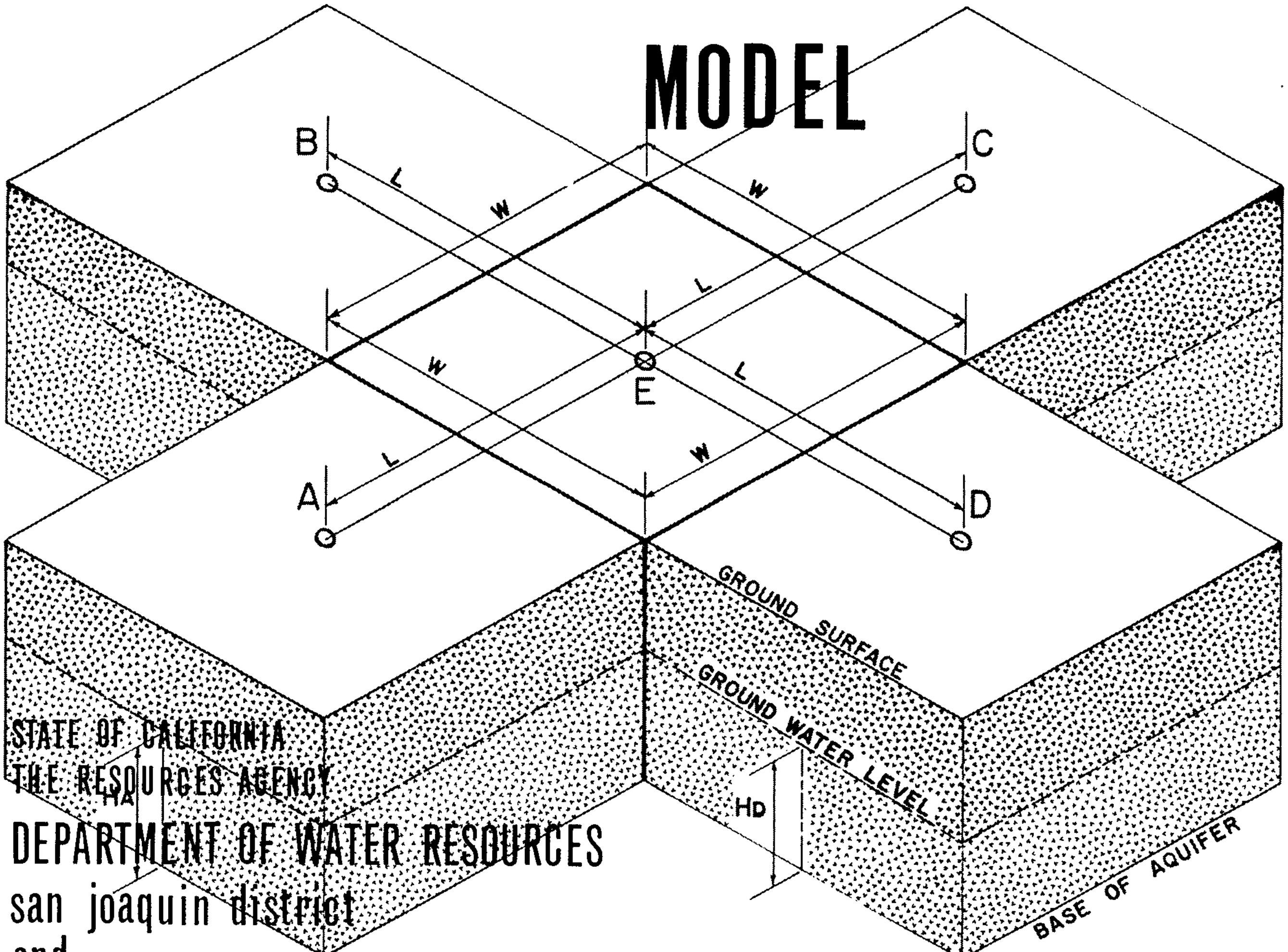
KERN COUNTY GROUND WATER MODEL



STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
san joaquin district
and
kern county water agency

DISTRICT REPORT
march 1977

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KERN COUNTY GROUND WATER MODEL
ERRATA SHEET

Page 1. Fourth paragraph, change "assimilate" to "simulate".

Page 2. Fifth paragraph, change "tendencies" to "estimates".

Page 5. Last paragraph, second sentence, delete "and flows" and add the following sentence: "Subsurface flow occurs between adjacent node points."

Page 6. Fourth paragraph, last sentence, insert "use of" after "through".

Page 7. Tenth paragraph, change heading to "Subsidence Water".

Page 8. Third paragraph, last two sentences, change to read: "Node data are shown in Tables 33 and 34 in Appendix C. Flow path data are provided in Tables 35 through 38 in Appendix C."

Page 10. Third paragraph, last sentence, change to read: "After additional information was collected, four more calibration runs were made over a 15-year (1958 to 1973) period."

Page 12. In Figure 1, delete "(Simulated)" from title.

Page 14. Sixth paragraph, first sentence, change "interesting" to "intersecting".

Page 21. First paragraph, fourth and fifth lines, change to: "Meridian, 18 kilometres -- about 11 miles -- below the Kern Canyon powerhouse) ...." Second paragraph, change "County" to "River". Last paragraph should read: "During a 76-year period from 1894 through 1970 ... 860 hm^3 (696,800 acre-feet) ...."

Page 23. Add the following sentence at end of the third paragraph: "Long-term median flow was used in simulation runs when projecting into the future."

Page 27. Add footnote to second column to show that Alpaugh ID is located in Tulare County. Water deliveries were made via Kern County.

Page 29. Fourth paragraph, second line, change "the" to "this".

Page 40. Last paragraph, add the following sentence: "Recent plans call for treatment of California Aqueduct water in lieu of recharge program and well field operation."

Page 49. In Table 15, cotton consumptive use is 2.58.

Page 51. Change last word on page to "outflow".

Page 87. In Table 22, add "median flow, 1894-1959 = 567,000".

Page 100. Add footnote to state that figures for years 1990 and 2020 were estimated.

Plate 4. 2nd point is located in the NE$\frac{1}{4}$ of Section 24, T30S/R25E, MDB & M.

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FOREWORD

This report describes a study undertaken jointly by the Department of Water Resources and the Kern County Water Agency to improve knowledge of the nature of the ground water basin underlying the San Joaquin Valley portion of Kern County so that its use, in conjunction with imported water, can be planned more wisely.

This ground water basin is a subsurface reservoir that, based on a 60-metre (200-foot) drawdown of water levels in its unconfined aquifer, contains as much as 40 cubic kilometres (32 million acre-feet) of usable water. This priceless resource is essential to the operation of the Valley's agricultural industry.

This cooperative effort resulted in a computer simulation of the ground water basin (i.e., a mathematical model that predicts the effects of different ground water pumping and recharge conditions, and of water import and use).

Creation of the model involved assemblage of a large, detailed data base, which improved knowledge of the basin's hydrology and geology and ultimately led to recognition of a number of potential problems and solutions.

Though not designed to deal directly with water quality problems, the model does indicate anomalous areas, and could be refined to better address this crucial aspect of basin management.

In addition to its broad, basinwide application, the model can assist water districts within the basin in their planning of import, recharge, and pumping activities. It is currently employed by the Kern County Water Agency to determine how imports from the California Aqueduct benefit Kern County's ground water basin. It will be useful to the Department of Water Resources in developing ground water storage projects for the State Water Project in Kern County.

Carl L. Stetson

Carl L. Stetson, Chief
San Joaquin District

CONVERSION FACTORS

English to Metric System of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches (in)	25.4	millimetres (mm)
		.0254	metres (m)
	feet (ft)	.3048	metres (m)
	miles (mi)	1.6093	kilometres (km)
Area	square inches (in^2)	6.4516×10^{-4}	square metres (m^2)
	square feet (ft^2)	.092903	square metres (m^2)
	acres	4046.9	square metres (m^2)
		.40469	hectares (ha)
		.40469	square hectometres (hm^2)
		.0040469	square kilometres (km^2)
	square miles (mi^2)	2.590	square kilometres (km^2)
Volume	gallons (gal)	3.7854	litres (l)
		.0037854	cubic metres (m^3)
	million gallons (10^6 gal)	3785.4	cubic metres (m^3)
	cubic feet (ft^3)	.028317	cubic metres (m^3)
	cubic yards (yd^3)	.76455	cubic metres (m^3)
	acre-feet (ac-ft)	1233.5	cubic metres (m^3)
		.0012335	cubic hectometres (hm^3)
		1.233×10^{-6}	cubic kilometres (km^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
		.028317	cubic metres per second (m^3/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
		6.309×10^{-5}	cubic metres per second (m^3/s)
	million gallons per day (mgd)	.043813	cubic metres per second (m^3/s)
Mass	pounds (lb)	.45359	kilograms (kg)
	tons (short, 2,000 lb)	.90718	tonne (t)
		907.18	kilograms (kg)
Power	horsepower (hp)	0.7460	kilowatts (kW)
Pressure	pounds per square inch (psi)	6894.8	pascal (Pa)
Temperature	Degrees Fahrenheit (°F)	$\frac{tF - 32}{1.8} = tC$	Degrees Celsius (°C)

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State of California
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San Joaquin District

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CHAPTER I. INTRODUCTION AND RECOMMENDATIONS

In 1967, the Department of Water Resources and the Kern County Water Agency (a county-wide agency serving 16 member water districts) initiated a cooperative, detailed study of the San Joaquin Valley ground water basin in Kern County.

The study had two objectives: (1) to determine the optimum method of operating the ground water basin in conjunction with existing surface water supplies and imports from the California Aqueduct and the Central Valley Project, and (2) to provide a basis for establishing "zones of benefit" resulting from importation of State water into Kern County.

The aim of the study was to develop a computerized mathematical model capable of predicting the ground water basin's behavior under a variety of circumstances. This report describes the hydrologic and geologic factors responsible for the model's formulation but makes no attempt to delve extensively into the model's history or to explain all the mathematical intricacies that contributed to its development. Instead, readers are referred to a review of the project's history (Rector, 1974) and to technical reports illuminating the mathematical hurdles (General Electric Company, 1968; Weber, 1966; Wilson, 1975).*

The Department and the Agency shared the task of creating a model designed to approximate the basin's characteristics. The model was developed in three stages: (1) all available hydrologic and geologic data were assembled and tailored so that all essential facts could be utilized; (2) calibration was undertaken to improve the model's ability to simulate historical ground water levels; and (3) hydrologic data were projected to assimilate several water supply and use conditions, enabling the model to anticipate ground water changes through 1990.

Creation of such a model required considerable geohydrologic and developmental planning, and during the calibration phase important conclusions were drawn regarding the relationship between geology and ground water movement. Some conclusions extended knowledge on existing geologic structures, while others suggested that some structures had a greater effect on ground water movement than was previously realized. During calibration, for example, it was determined that the confining clay was more extensive than previous studies had

*Computer work was contracted with the General Electric Company (TEMPO) in Santa Barbara (General Electric Company, 1968).

indicated, and additional geologic structures, responsible for the obstruction of ground water flow, were discovered. In lower and single-layer aquifers, it was ascertained that ground water flow does not occur down to the base of the fresh water, as once suspected. Further, transmissivity in older formations (Kern River and Chanac, among others) was less than in younger sediments.

The calibration process also emphasized the need for additional data on the two modeled aquifers -- particularly in areas where water from both aquifers is unused or where monitoring devices are not installed. Data are also lacking in one area northeast of Poso Creek where the Santa Margarita formation is the main aquifer and another west of the modeled area between Elk Hills and Lost Hills. In addition, calibration also generated a series of recommendations designed to enhance the model's value (see pages 63 and 64).

In the use of this model, it should be noted that the accuracy of the ground water model is limited: first, by the spacing of the nodes, and also by their shape relative to the principal ground water flow paths and boundaries. The computer views the 5 000-square-kilometre (2,000-square-mile) study area in the San Joaquin Valley as a series of polygonal nodal sections, each containing about 24 km^2 (9 square miles) as shown on Plate 1. While, in general, node size and shape presented few problems, difficulties did arise in two areas where significant ground water flow was directed approximately diagonal to the nodal boundaries. This occurred in the alluvial fans of Kern River and Poso Creek, where flow along steep-sided ground water mounds could not be simulated accurately without requiring an up-gradient flow.

The model's hydrologic balance is affected by subsurface phenomena involving substantial quantities of water. These phenomena include yield from lowered ground water levels, subsurface boundary flow, yield due to land subsidence, and loss of water due to moisture-deficient soils.

Projected water level trends -- based on future supply and demand tendencies, as well as district plans and contracts in effect in 1973 (described in terms of a ten-year period from 1980 to 1990) -- will decline approximately 0.6 metre (2 feet). Water level projections are presented in Table 1 in terms of areas covered by organized water districts. Water districts are approximated on Plate 2 by nodal area boundaries.

Recommendations

Although the model is much more accurate than previous methods for predicting future water levels in Kern County and is probably sufficiently accurate for determining

TABLE 1

WATER LEVEL TRENDS BETWEEN 1980 AND 1990
AS REPRESENTED BY NODAL AREA BOUNDARIES
SHOWN ON PLATE 2
(in feet)

Location	Confined	Unconfined
Wheeler Ridge-Maricopa	+9 to +12	+14 to +45
Arvin-Edison and Wheeler Ridge-Maricopa	+7 to +11	-2 to +40
Greater Bakersfield	+4 to +22	-19 to +28
South Buena Vista	+5 to +7	At ground surface by 1980
Arvin-Edison	+5 to +7	-4 to +20
Cawelo	--	-13 to -37*
Rosedale-Rio Bravo	+1 to -16	-8 to -22
Shafter-Wasco	-12 to -18	-14 to -23
North North Kern	0 to -18	-7 to -20
Semitropic	-7 to -14	+9 to -16
Southern San Joaquin	-10 to -12	+1 to -17
Pond Poso	-5 to -11	+21 to -9
Lost Hills	-9 to -18	+7 to -12
Buttonwillow	-4 to -12	+14 to -14
North Buena Vista	-2 to -9	+12 to -12
Kern Delta	+1 to +6	+14 to -10
Rag Gulch	--	-25*
Kern-Tulare	--	-47 to -56*
Delano-Earlimart	-14	+1 to -18
South North Kern	+3 to -7	+3 to -10

*Much of the water is produced from the Santa Margarita formation which is confined, but the nodes were treated as unconfined in the model.

the most efficient manner to operate the basin, parts of the model and its data base may require additions or improvements. To help water planners anticipate the effects of different options, the model's data base must be kept current.

In line with the above observation, it is recommended that:

1. The model's data base be kept up to date by continuous monitoring of hydrologic information, including major surface water supplies, irrigated acreage, per capita water use, population projections, and irrigation efficiencies.

2. Data be collected for a study of the northeast portion of the model to determine the rate of recharge to the Santa Margarita formation, the effects of the Hodgeman Ranch and Premier faults (shown on Plate 3), and water movement in the Santa Margarita formation.

3. Observation wells be constructed west of the California Aqueduct to determine boundary ground water conditions and water quality. Moisture deficiency information could be obtained from soil samples gathered when the wells are drilled.

4. Drillers' logs filed since completion of this study be researched for wells completed in only one aquifer, since data from wells completed in more than one aquifer cannot be used to calibrate the model.

5. When additional observation wells above the "A" clay are available, a third aquifer should be monitored north of Spicer City and beneath the Buena Vista and Kern lakebeds.

6. As data become available on water levels outside the modeled area, "dummy" nodes should be utilized so that the model will compute the subsurface inflow around its own periphery.

7. For as long as subsidence persists, subsidence areas should be resurveyed at five-year intervals.

8. Future subsidence rates should be related to water level trends in the model.

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CHAPTER II. GROUND WATER MODEL FORMULATION

The simulation model of the Kern County ground water basin was formed by first dividing the 5 000-km^2 (2,000-square-mile) study area into polygons containing about 23 km^2 (9 square miles) each, as shown on Plate 1.

The model, which treats each polygon as a single point or node, was then given a description of the geologic conditions governing subsurface water flow and storage -- flow between layers, subsurface flow between nodes, and aquifer void space for water storage.

Another set of data described water levels in, and water flow to and from, the surfaces of the nodes -- items such as imported water, rainfall, natural streamflow, evaporation, plant use, and deliberate ground water recharge.

As an ideal, the model would have complete and accurate information on every aspect of water supply, storage, use, and flow in the basin. As a practical matter, however, that information is limited -- in some cases severely -- and as a result, the model's answers are limited in accuracy by the degree of uncertainty in the information which is given.

The complex task of the digital computer is similar to that of the accountant: it must work with the intricately interrelated items of water supply and demand, within the framework of the basin's hydrology and geology, to arrive at an adjusted balance. The computer's answer is a description of the changes in the ground water levels in each nodal area for a given set of water supply and use conditions.

Nodal Areas

As illustrated on Plate 1, the basic nodal shape is rectangular, although in the southeast portion some of the polygons were designed with irregular shapes so that boundaries coincided with fault zones known to influence ground water flow. (After completion of the model, other flow restrictions were recognized, suggesting that further changes in some polygonal shapes might improve the model.)

The dots that appear in the centers of the nodal areas are the mathematical node points used in the model. For calculative purposes, all changes and flows were assumed to take place at the nodes, and the effects spread uniformly over the nodal areas.

Because a subsurface clay layer separates two water-bearing layers in part of the basin, the model was designed with nodes blanketing the entire surface to deal with the unconfined (upper) aquifer and others for the confined aquifer below the clay layer. That resulted in 217 nodes with descriptions of the unconfined aquifer and 174 nodes for the confined aquifer.

On the north, where water-bearing sediments extend into Kings and Tulare Counties, 28 "dummy" nodes (nodes with predetermined water levels, as opposed to computed water levels in regular model nodes) are used to establish subsurface flow conditions. For nodes at the south, east, and west boundaries, annual estimates of subsurface flows from outside the model area were added to the water accounting.

Variable Input Data

Each node on the model was assigned variable hydrologic input data to cover 18 categories. These items vary with time and usually have different values for each year modeled.

Irrigated Agricultural Lands. This information is obtained from periodic land use surveys. Detailed land use surveys conducted in 1958 and 1969 determined the crop pattern in agricultural areas, and a 1966 survey ascertained only the changes in acreage irrigated. The annual incremental change in irrigated area between years of survey is assumed to be linear. Annual updating is scheduled to be accomplished through remote imagery.

Consumptive Use by Agriculture. Unit consumptive use was estimated for each major crop grown in Kern County. Each nodal area has an average consumptive use, determined from unit use weighted by the acreage of each crop grown in the nodal area.

Applied Water by Source. The sources of applied water are a variety of surface water supplies imported to the nodal areas. Ground water, when needed to meet the total demand, is automatically extracted during the simulation process, according to a formula that includes an irrigation efficiency factor.

Recharge by Source. Cases of deliberate and incidental recharge to the ground water basin are included in this category.

Conveyance Loss to Deep Percolation by Source. Percolation losses from irrigation canals are included in this category.

Evaporation by Source. This item lists evaporation from all free water surfaces, including a percentage of annual flow in canals, rivers, and recharge basins. It does not include evapotranspiration from irrigated fields.

Exports by Source. This category applies only to water exported from the model area.

Total Surface Inflow by Source. Total surface water supplies to the model area, as determined from historical records, are tabulated and compared with the sums of individual portions supplied to each node. This comparison serves as a check to assure accounting for all surface inflow.

Unit Effective Precipitation. This item is defined as direct rainfall intercepted by crops during the growing season that did not exceed the crops' consumptive use requirement. The weighted average factor is related to both crop type and growing season. It varies annually but is consistent for all nodes. An average unit factor is used in projection runs.

Recreational Irrigated Land. This factor deals with nodes where land is irrigated to maintain wildfowl habitats.

Unit Recreational Consumptive Use. This factor concerns the per acre amount of water used to maintain wildfowl habitats.

Population. This item concerns urban population in each node. It is determined from U. S. Census figures and from predictions supplied by the Kern County Planning Commission and the State of California.

Percentage of Municipal Extractions. This item allows for allocation of ground water extractions to more than one node. Distribution is based on a percentage of total municipal extractions.

Imports. This item represents the volume of water imported to the model area for municipal and industrial use. Imports reduce ground water extractions by supplying a portion of the total demand.

Subsidence. This item represents water released from storage by subsidence.

Subsurface Inflow. This item is the amount of ground water flow that crosses beneath the surface of the model area's external boundary.

Oil Field Waste Recharge. Percolating oil field waste waters constitute a small portion of the model area's annual ground water recharge. It was assumed that about half the oil field waste water from sumps percolates, while the other half evaporates.

Dummy Node Heads. This item establishes the hydraulic heads in dummy nodes used to define boundary conditions on the north edge of the model.

Fixed Factors

In addition to the variable factors outlined above, the model was given information on a series of fixed factors describing the characteristics of the ground water basin. Although some of these items were changed between runs to improve calibration, they remained fixed throughout the time period simulated in any one computer run.

Nodal Area Geometry. This description concerns the lengths and widths of the flow paths between the nodes as well as the elevations of the tops and bottoms of the flow paths and the area and elevations of the tops and bottoms of the nodes. Node data are shown in Tables 31 and 32 in Appendix B. Flow path data are provided in Tables 33 through 36 in Appendix C.

Transmissivity. This factor expresses the water's rate of flow through a unit width of the aquifer under a unit hydraulic gradient. It describes the characteristics of the aquifer between nodes.

Specific Yield. This factor is defined as the percentage of soil volume that will store and yield water by gravity. The specific yield item is for confined and unconfined aquifers but applies to the confined aquifer only if the water level drops below the confining clay. Water levels remained above the bottom of the clay for all past and future conditions modeled.

Storage Coefficient. This term refers to the change in water storage in the confined aquifer that occurs with a change in hydraulic head.

Percentage of Node Underlain by Moisture-deficient Soil. This item defines the percentage of percolating water lost to soils containing less moisture than the specific retention factor.

Volume of Water Required to Satisfy Moisture Deficiency. This item represents the volume of water required in 1958 to raise the soil moisture percentage to specific retention. The initial value decreases annually as soil moisture accumulates through deep percolation of applied water.

Percentage of Node Underlain by Perched Water Table. The model allows designation of a percentage of percolating water to shallow perched aquifers, but the option has not been used because it does not appear to adequately model the phenomenon.

Unit Demand. Per capita municipal and industrial water demands were based on historical uses in the Bakersfield area. The demands are expected to remain fairly constant from year to year.

Percentage Pumped from Lower Layer. This factor divides the total municipal, industrial, and agricultural ground water extractions between the upper and lower layers in the two-layer portion of the model.

Percentage Export Pumped in Lower Layer. This factor divides the total ground water extractions for export between the upper and lower layers in the two-layer portion of the model by specifying the percentage of lower-layer extractions.

Lower Layer Not Present. This factor allows direction to the model that the lower (confined) layer is not present in the nodal area.

Percentage to Deep Percolation. This item represents the portion of municipal and industrial demand (other than municipal waste water) that percolates to ground water.

Consumptive Use Percentage. This factor determines the percentage of per capita municipal and industrial water demand that is used consumptively. The percentage is derived from water use studies conducted in Bakersfield and other cities.

Percentage to Sewerage. This item represents the portion of per capita municipal and industrial water demand that becomes sewage. It is estimated from water use studies conducted in Bakersfield and other cities.

Percentage of Waste Water Applied. The proportion of treated waste water used in land disposal areas is represented by this item. It is accounted for as a source of applied water for agriculture. The unapplied remainder is assumed to deep percolate.

Irrigation Efficiency. Average irrigation efficiencies were computed by nodal areas on the basis of crop type. The fraction used is a weighted average and represents the percentage of applied water used by plant evapotranspiration.

Historical Heads. This item assigns the initial water levels to establish the starting point for simulation computations of the model's nodes. It also includes annual measurements for the remaining years of the calibration period.

Items Projected as Fixed Quantities

To compare different projections, the computer receives special instructions regarding three subsurface hydrologic items: water yield from subsidence, subsurface boundary inflow, and water levels in dummy nodes. Before the model run, these items are submitted as fixed values, as opposed to being calculated by the model in response to a water situation defined by a potential set of conditions. The assumed subsidence rate, for example, should be greater with no California Aqueduct water than with a full aqueduct supply on which to rely. Similarly, special consideration must be given to subsurface boundary inflows (excepting the north boundary) and to water levels in the dummy nodes that fix the subsurface flow conditions at the north boundary.

Calibration Process

During the calibration process, the computer began with initial nodal water levels and utilized historical water supply and use information to reconstruct base period nodal water levels, which were compared to those measured. Adjustments were made in the various parameters, describing surface and subsurface hydrology and geology to achieve better agreement between the model's predictions and available historical data on ground water elevation changes. The initial base period (1958 to 1966) was established on the basis of data available for this purpose. Extension of this term through 1973 was made as the information became available.

The first 29 calibration runs relied on data compiled during the 1958-66 base period. Additional information was collected from four more runs, conducted over a 15-year (1958 to 1973) span.

Water Level Data

In the simulation process, the variable input to the model is the net amount of water annually extracted from or recharged to the surface of each polygonal node -- an input derived from a preliminary computer operation that deals with the variety of surface hydrologic activities discussed earlier.

The model's answer is a calculated, annual ground water elevation at each node.

Changes in ground water storage (which are proportional to the changes in water levels) plus subsurface flows for each node must balance the annual amounts recharged or extracted within an error limit of plus or minus 12 000 cubic metres (10 acre-feet) at each node.

Model calibration accuracy is monitored by a computer-graph (printed for each node) displaying the model's computed and historical water levels for each year of the calibration period.

A typical hydrograph from Operational Run A, covering the period 1958 through 1990 and showing the historical and computed water levels for the 1958 through 1973 period, is shown on Figure 1.

If historical water level trends and model computations are parallel, future water levels projected by the model for such nodes would be reasonably accurate.

If the trends converge or diverge -- especially near the end of the calibration period -- future water levels projected by the model for such nodes would be less reliable.

The accuracy of nodal calibration is also affected by the amount of hydrologic activity at the node during the calibration period. When nodal ground water levels have undergone large changes during the calibration period -- especially if the changes include water level increases and decreases -- the response of the node to a large range of hydrologic activity has been tested.

On the other hand, if historical water levels have undergone little or no change, the response of the node has only been tested for a limited range of hydrologic activity.

Classes of Water Levels in Model. Historical water levels are divided into three classes (initial, dummy node, and comparison) according to their function in the model.

Initial Water Levels. Initial water levels are those recorded at the beginning of the first year of the modeling period -- 1958 for the calibration runs. These water levels define the elevation of ground water in storage as well as the gradients that cause subsurface flow at the beginning of the calculations. Every node has an initial water level; therefore, if no measurements are available, an estimate is made.

Dummy Node Water Levels. Dummy node water levels are those assigned to the nodes in Kings and Tulare Counties on the model's north boundary. They have an assigned value for each year, and, in conjunction with the computed water levels of the contiguous nodes inside the model, they determine the hydraulic gradient causing subsurface flows across the boundary.

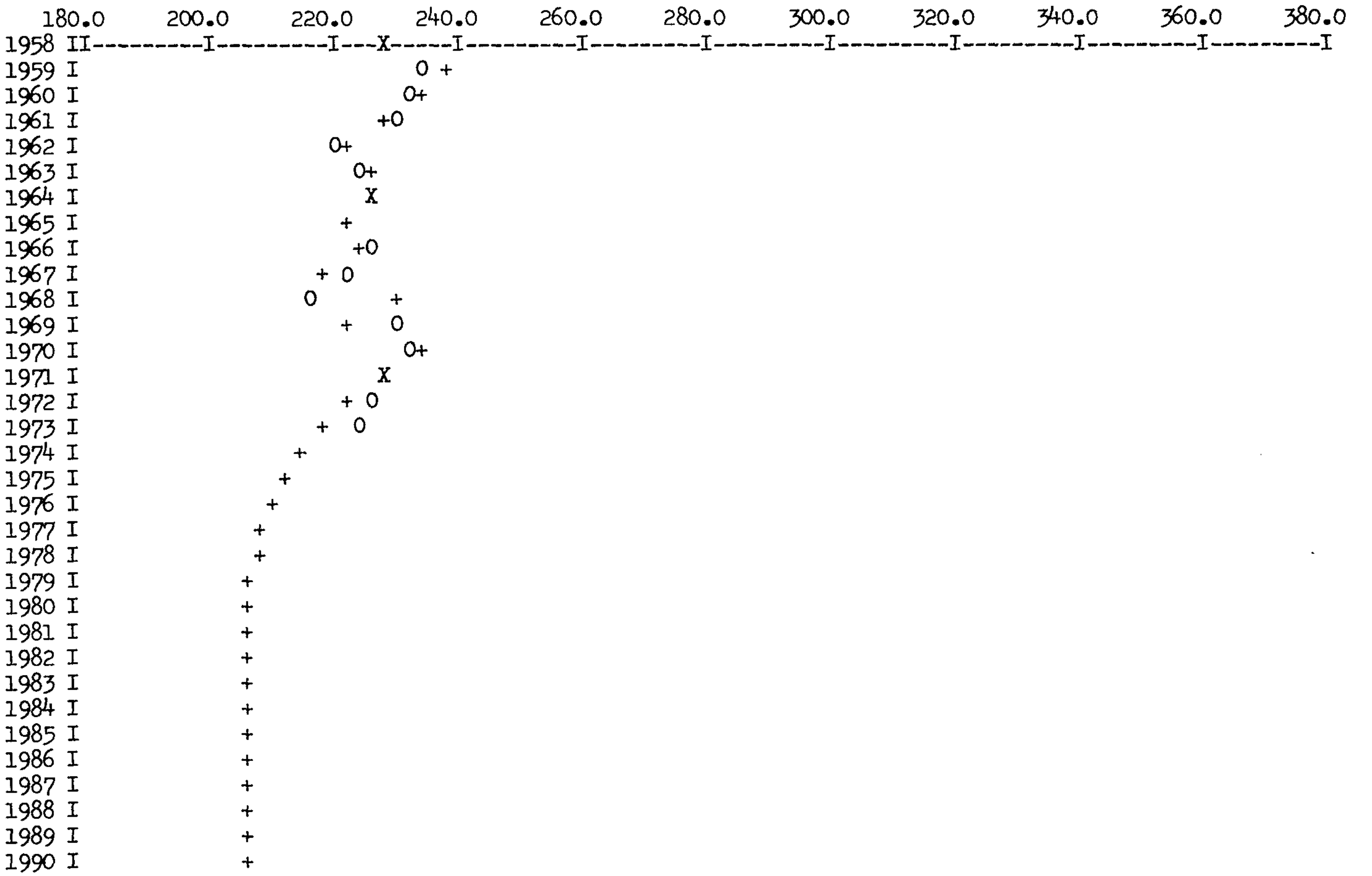
Each dummy node has an assigned annual water level, and missing measurements for the calibration period are estimated. For projections, future water levels in contiguous parts of Kings and Tulare Counties must be estimated based on projections of water supply and demand for those areas. The estimated levels are adjusted each year as new water level measurements are published by the Department of Water Resources.

FIGURE 1

COMPUTER-PRINTED HYDROGRAPH

FOR NODE 104
(Simulated)

KERN COUNTY GROUNDWATER INVESTIGATION OP RUN A BASIC FORECAST, INCLUDES CALIFORNIA AQUEDUCT WATER



Year	COMPT	HIST
1958	228.0	228.0
1959	237.6	234.0
1960	233.0	232.0
1961	228.0	229.0
1962	222.0	220.0
1963	225.7	224.0
1964	226.8	226.0
1965	221.4	
1966	223.7	225.0
1967	217.4	221.0
1968	230.8	215.0
1969	221.7	230.0
1970	233.5	231.0
1971	227.1	227.0
1972	222.3	225.0
1973	217.4	223.0
1974	214.6	
1975	212.0	
1976	210.1	
1977	208.7	
1978	207.7	
1979	206.9	
1980	206.4	
1981	206.0	
1982	205.8	
1983	205.7	
1984	205.6	
1985	205.6	
1986	205.7	
1987	206.0	
1988	206.2	
1989	206.5	
1990	206.7	

ELEVATION IN FEET ABOVE SEA LEVEL VERSUS TIME IN YEARS

O = Historical water level elevation
+ = Computed water level elevation
X = Point where computed and historical
water levels coincide

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Comparison Water Levels. Comparison water levels do not enter into the computer calculations. These levels, measured for the calibration period, are the standards that the computed water levels are compared with to determine if the model's calibration is satisfactory. It is important to determine the authenticity of the historical water level before the computed water level is discounted.

When making comparisons with the standard, it should also be noted that the computed hydraulic head is an average water level for the node, while the historical water level -- the water level measured in an individual well in the node -- represents the water level at a single point and may be influenced by local transient phenomena such as nearby pumping or recharge.

Determination of Historical Ground Water Elevations

Historical ground water levels used in Calibration Runs 1 through 10 were determined from water-level contour maps prepared by the Department.

Since these contour maps require interpretation between the measured wells, and because well data are sparse in some areas, several of the resulting nodal hydrographs tended to fluctuate without relationship to ground water pumping or recharge.

Historical records covering about 25 nodes had one or more points in error by as many as 24 metres (80 feet), relative to selected observation wells or projected water levels for other years. Many of the larger errors were in nodes along Semitropic Ridge and nearly all were north of Kern River.

Water levels for the upper layer (based on Department contour maps) also appeared to have a bias toward lower elevations. This was probably caused when contours were drawn to measurements from wells perforated in both aquifers when no upper aquifer well measurements were available.

Measurements from Selected Observation Wells. To eliminate large errors and obtain historical ground water levels that more closely approximate the true fluctuations of ground water levels in the two main aquifers, water levels based on contour maps were replaced by levels based on selected observation wells.

Criteria for selecting wells were that (1) reported depth or perforated intervals limited the well openings to one aquifer; (2) measured water levels corroborated the single-aquifer construction; (3) measurements were as nearly continuous as possible through the 1958-67 calibration period; and (4) if more than one well met the first three tests, the one nearest the node center was selected.

Water levels from wells located up- or down-gradient from the node centers were sometimes used, after adjustment, by adding or subtracting a constant from all measurements.

Revised Water Levels. Use of historical nodal water levels based on the selected observation wells greatly improved the model calibration. One undesired result was that many nodes were left without historical water levels as a basis for calibration because no observation wells could be found. But on the other hand, the model was not forced to match data of questionable value that could have been misleading.

Water levels for most of the unconfined nodes were based on observation wells for all runs after Calibration Run 10. More water levels from observation wells were added before Runs 18 and 19, and after Run 28 the modeling time was extended from 1958-67 to 1958-73. For the extended period, observation wells were selected for 30 nodes where no historical water levels were available for the earlier period.

No observation wells to determine initial water levels were found for 48.6 percent (190 of 391) of the nodes in the spring of 1958. Water level measurements specific to only one aquifer were not found for any year of the entire 16-year period (1958 through 1973) for 35.8 percent of the nodes (140 of 391). Between 1958 and 1973, the number of nodes with measured water levels ranged from 192 (in 1958) to 144 (in 1965) and averaged 167, or 42.7 percent.

No suitable observation wells were found for a line of unconfined nodes along Semitropic Ridge, or for an interesting alignment of nodes trending from Goose Lake to Wasco. Water level data for unconfined nodes were also absent south of Buena Vista and Kern Lakes and for several nodes along the east side of the model (north of Bakersfield). In all, no wells representative of the unconfined aquifer were found for 21.7 percent (47 of 217) of the unconfined nodes.

In the confined nodes, only a few observation wells were found along the entire west side, and only about a dozen confined nodes in the south half of the model had observation wells. Some of the nodes with data were near the east edge of the confining clay, and the remainder were just north of Wheeler Ridge. No water level measurements were found for any of the 16 years for 53.4 percent (93 of 174) of the confined nodes.

Observation wells drilled by the Department and the U. S. Bureau of Reclamation improved water level data in the model area.

Twelve core holes drilled in Kern County in 1951 and 1952, as part of a Bureau program in the San Joaquin Valley, provided water level data for the unconfined nodes. Ten other holes furnished data for confined nodes.

Between 1967 and 1969, the Department drilled 18 observation wells near the California Aqueduct alignment -- most of them in the 60-to-90-metre (200-to-300-foot) range. For the extended 1958-73 period, the Department's observation holes provided water level data for 3 confined and 14 unconfined nodes.

Improvements in Water Level Data. Location or construction of a minimum of 20 observation wells would be required to fill the gaps in ground water elevation data. As a first step, another thorough canvass should be made in nodes without water level data, using the criteria mentioned above to select additional observation wells.

Model Operation

After the calibration process was complete, the model was given several sets of future water supply and use conditions and was operated to predict the ground water level changes that would take place under these conditions through 1990.

For each of these future water conditions, the model can predict the elevation of water levels and areas where future drainage problems may occur. It can predict, for example, what will happen if greater water imports are made to the east side of the Valley, or if west side (California Aqueduct) deliveries are less than anticipated.

It can also predict the effect -- again in terms of water level changes -- of modifications in crop patterns or irrigation methods.

Although the model, as calibrated, is believed to reasonably approximate the real situation in the ground water basin, adjustment and improvement processes continue.

As new information is obtained on the basin's hydrology and geology, the model's mathematical description of the basin, along with its predictions of changes, can be improved. Periodic updating of land use information and replacement of imported water estimates with historical data will keep the data base current and make future estimates more realistic.

Projected Futures

The norm to which alternatives are compared is based on current or planned water delivery system schedules established as of 1973 by the Kern County Water Agency's member districts and other water districts. The basic projection from 1958 through 1990 is labeled Operational Run A and was conducted on May 30, 1974.

Surface Water Supply Projections. Future surface water deliveries for Operational Run A are distributed to the nodal areas according to water supply contracts and in keeping with the average deliveries of water supplies established during the 1958-66 base period.

Future deliveries from the Kern River are based on long-term, regulated median flows monitored at the First Point gaging station. The deliveries are distributed to nodal areas according to use patterns established during the base period.

Future water deliveries from the Friant-Kern Canal are founded on average project allocations. The distribution pattern is the same as during the base period in all areas except the Arvin-Edison Water Storage District, where normal supplies were not received during the base period.

Future California Aqueduct water deliveries are scheduled according to existing water service contracts with the Kern County Water Agency.

Agricultural System. Future agricultural trends are determined from current water district plans. The agricultural water demand of each nodal area is calculated from unit water uses and irrigation efficiencies for each crop type. If surface water deliveries and effective precipitation fail to satisfy agricultural demands, the model computes ground water extractions required to meet water needs.

The computerized program controls the relative amounts of ground water extracted from confined and unconfined aquifers. The ground water reservoir is recharged through deep percolation, although absorbent moisture-deficient soils inhibit this process in certain areas.

Municipal and Industrial System. Municipal and industrial water uses are related to the population projections of urban nodal areas. Per capita water demands not met by imported water are satisfied by ground water extractions. In each nodal area, empirical factors are used to determine the fraction of total demand lost to deep percolation, consumptive use, and waste water treatment plant disposal.

Waste water from treatment plants is available for agricultural purposes. Otherwise, it percolates into the underground reservoir.

Population projections, ground water extraction plans, and waste water disposal techniques are used as data control references for the operation of this system.

Computer Calculations and Answers

The computer views the ground water basin as a series of nodal areas. Actually, these areas are cells described by surface area and the depth of the aquifer. Where a two-layer aquifer exists, the model uses one cell to describe the upper aquifer and another (below it) to depict the lower aquifer.

Water movement between cells is defined by complex differential equations. These equations -- one for each cell -- are solved by a "relaxation" method in which the computer makes a succession of flow and water level estimates, reducing its margin of error with each appraisal. In this manner, the computer determines the volumes and rates of subsurface water flow resulting from the model's combined hydrologic activities. Water level variations are computed as the annual water level balance is calculated.

Computer printouts summarize annual water levels and balances for (1) each nodal area, (2) selected nodal groups that approximate water district boundaries, and (3) the model area as a whole to encourage result-comparisons of different water management plans.

Water elevations at nodal centers can be used to evaluate long-term simulation runs. Ground water contour maps can also be drawn for more detailed analysis.

Information provided by the model is utilized by the Kern County Water Agency to determine the effect that imported, California Aqueduct water has had on ground water levels.

Although the model was designed to evaluate subsurface water flows, and not water quality, some of the model's predictions suggest that water quality problems will likely occur along the northeast and west sides of the model area.

Projected Water Level Trends. Operational Run A (May 30, 1974) predicted the response of the ground water basin to future water supply and demand, based on district plans and contracts in effect in 1973.

The average ground water level trends for the entire model area (described in terms of a ten-year period from 1980 to 1990) show a slight decline of approximately 0.6 metre (2 feet). After recommended changes are made in the future rates of subsurface inflow and subsidence, the predicted rate of decline is expected to increase slightly. This is a reflection of predicted future overdraft conditions, which have been modified both by subsurface inflow from basin storage outside the modeled area and by water produced through compaction of voids during subsidence.

In evaluating the reported trends, it should be kept in mind that a decline in an unconfined aquifer's water level represents dewatering of pore space and therefore a significant change in ground water storage. A decline in confined aquifer levels, however, represents a pressure change with only a slight storage change. Water level trends are shown in Table 1 in terms of areas covered by organized water districts or improvement districts, approximated by nodal area boundaries on Plate 2. All values for water level changes refer to the ten-year change from 1980 to 1990.

Evaluation of Model

Operation of the ground water model was assessed for the Kern County Water Agency by Mr. Charles R. Wilson of the Leeds, Hill & Jewett consulting firm, in connection with the Agency's use of the model to determine "zones of benefit" from California Aqueduct water (Wilson, 1975).

Using statistical techniques to compare computed and historical changes in water levels, the assessment concluded that on an overall basis the system "quite accurately" modeled the unconfined aquifer but added that, judging from available data on actual changes in water pressures, the confined aquifer was modeled less accurately. Still, if the model's projections of future events are "generally correct", the report states, "the ... analysis of the accuracy of the ground water model has shown that it would be possible to forecast long-term trends and averages with reasonable accuracy."

CHAPTER III. HYDROLOGIC FACTORS IN MODEL CALIBRATION

Calibration of the ground water model depends on an accurate accounting of all water flows in and out of the model area during a carefully selected base period.

The main sources of water for the model area are the Kern River, the Friant-Kern Canal, and more recently, the California Aqueduct. The major withdrawal of water from the area is due to consumptive use by agriculture.

These and other elements of the water accounting balance were examined in detail to establish the essential relationship between inflow, outflow, and changes in the ground water basin storage during the base period.

Selection of Hydrologic Base Period

An ideal hydrologic base period usually represents long-term hydrologic conditions in the basin. It will also include normal and extreme conditions and be well documented. Further, if the beginning and end of the base period are preceded by dry years, the accounting for "water in transit" is minimized. "Water in transit" is water moving through the unsaturated zone between the land surface and the water table.

The years 1958 through 1966 were chosen as a base period for the Kern County ground water model study, with data availability the greatest factor in the decision. The most reliable record of ground water extractions from the basin was compiled by the U. S. Geological Survey for the 1962-66 period. Department information gathered in a 1958 land use survey was also available, along with data collected in a survey of irrigated lands completed in 1966. Water in transit, or moisture in storage, in the vadose zone at the beginning and end of the base period can be assumed to be equal since the source of the percolating water is the regularly applied water supplies rather than precipitation -- supplies that do not vary greatly from year to year.

Base Period Deviations from Average

Precipitation during the base period was nearly normal, although it did not include any extremely wet years, and the beginning and end were not immediately preceded by dry years. Water supply from subsidence is nonrecurring and will not be available when water levels are lowered again. Water loss to moisture-deficient soils is also nonrecurring.

Precipitation

Precipitation records from seven stations in the basin were examined and compared to determine the percent deviation of the base period average from the long-term historical average. Station locations are shown on Plate 4, and a summary of each station's precipitation record is provided in Table 2.

TABLE 2

LONG-TERM AND BASE PERIOD
MEAN PRECIPITATION AT SELECTED STATIONS

Station and Period	Long-term Mean (inches)	Base Period Mean (inches)	Percent Deviation
Bakersfield Airport 1937-1966	5.94	5.26	- 11.4
Buttonwillow 1940-1966	4.95	4.89	- 1.3
Delano 1950-1966	6.55	6.97	+ 6.4
Lost Hills 1913-1966	5.36	5.30	- 1.1
Taft 1949-1966	5.26	5.68	+ 7.9
Tule Field 1949-1966	5.13	5.03	- 2.0
Wasco 1899-1966	6.17	6.15	- 0.3

Surface Runoff

The effects of the Kern River's regulated runoff are probably more crucial than those of precipitation in determining the amount of water in transit in this arid area during a base period.

A 73-year history of Kern River flow at a location designated as First Point (southwest quarter of Section 2, Township 29 south, Range 28 east, Mount Diablo Base and Meridian, 1.6 kilometres -- about a mile -- below the Kern County powerhouse) shows the long-term mean runoff to be 824 hm^3 (668,200 acre-feet) per year. The calendar year regulated mean for the 1958-66 base period was 631 hm^3 (511,800 acre-feet) per year, or 76.6 percent of the long-term average.

The record of Kern County runoff is shown graphically in Figure 2.

Surface Water Inflow

Surface water inflow is defined here as that water entering the modeled area in major and minor stream channels and in canals. Streams and conveyance facilities are shown in Plate 4.

During the 1958-66 base period, the annual surface water supply to the ground water basin area of Kern County averaged approximately 918 hm^3 (744,000 acre-feet) per year. About 69 percent of this supply was Kern River runoff, while 27.5 percent was Friant-Kern Canal water and 3.5 percent was minor streamflow.

In making projections, consideration must be given to (1) the Friant-Kern Canal, which will eventually deliver approximately 493 hm^3 (400,000 acre-feet) of water annually to this area, and (2) the knowledge that increasing amounts of water will be delivered from the California Aqueduct. Aqueduct deliveries began in 1968, with an initial delivery of 157 hm^3 (127,400 acre-feet). The maximum delivery of approximately 1 546 hm^3 (1,253,400 acre-feet) per year (including surplus waters) is now expected in 1981 instead of 1990 as was originally projected.

Kern River Inflow

The Kern River, which originates in the Sierra Nevada and enters the Valley near Bakersfield, is the only major stream in Kern County. Annual variations in water supplied by the river are reflected in changes in ground water levels in the basin area.

Runoff from the river has been recorded at First Point since 1894. The record is shown on Figure 3 and tabulated along with other surface supplies in Table 22 (Appendix B).

During a 73-year period from 1894 through 1966, First Point flow averaged 824 hm^3 (668,200 acre-feet) per year and

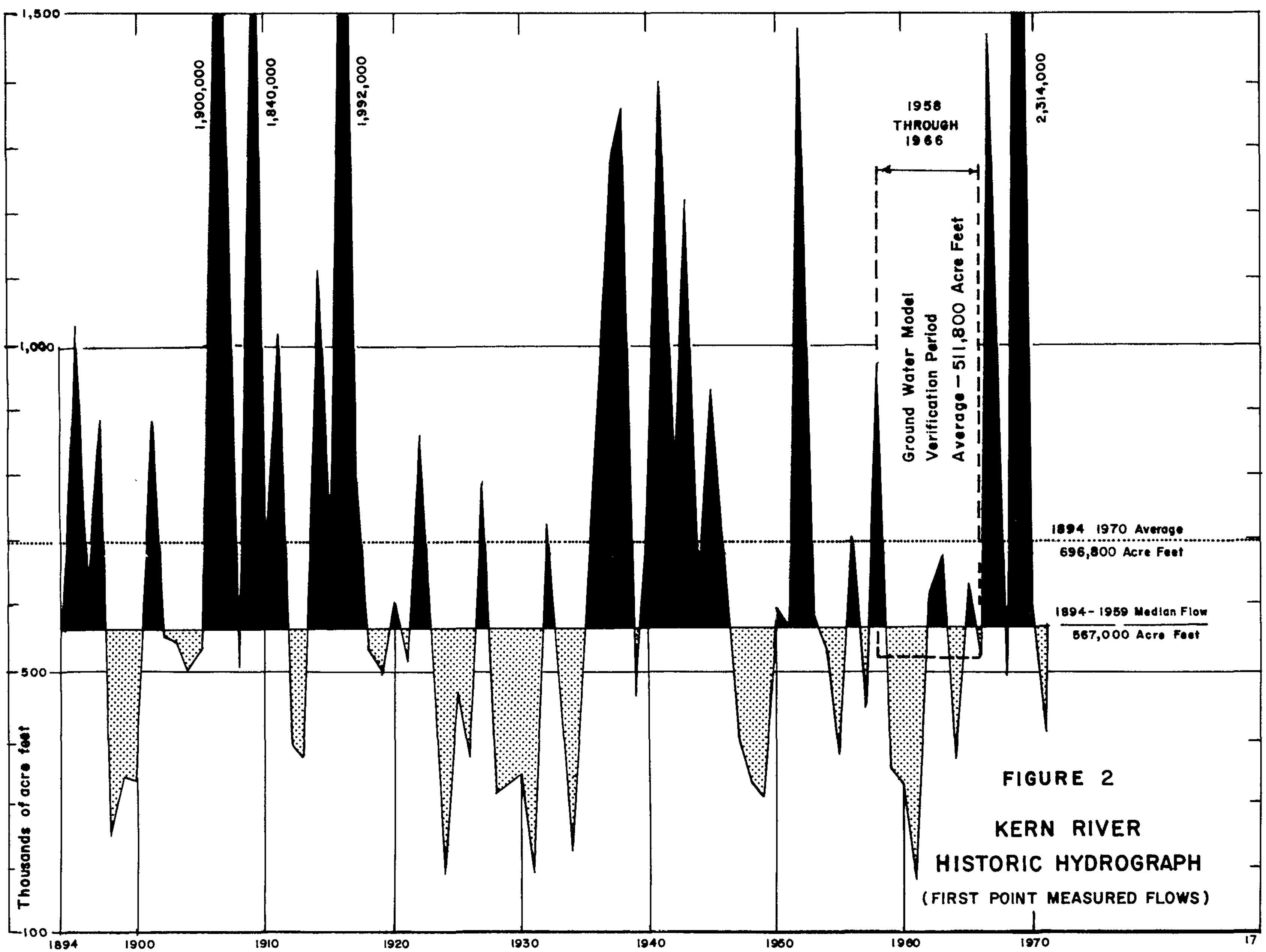

FIGURE 2

KERN RIVER
HISTORIC HYDROGRAPH
(FIRST POINT MEASURED FLOWS)

ranged from an annual high of 2 457 hm^3 (1,992,000 acre-feet) to an annual low of 218 hm^3 (177,100 acre-feet). The historic maximum flow of 2 854 hm^3 (2,313,800 acre-feet) was measured during 1969.

Isabella Dam, a flood control project on the Kern River, was completed in 1954. Regulated flow from 1954 through 1971 averaged 823 hm^3 (667,500 acre-feet) per year.

In the model, the computer was given the Kern River diversions as the total Kern River flow. The First Point records -- which presumably represent the entire flow into the model, except for the rare instances where flood flows leave the model area -- were used as a check on the diversion totals. Because of gaging problems in the First Point flow or diversions (or both), the two figures do not agree precisely for all years of the base period, although the differences between annual totals are considered to be well within acceptable limits of accuracy for gaging flows and deep percolation losses of this magnitude.

Minor Stream Inflow

Flow records have been established on several minor streams in Kern County, but records covering a period of five years or more are available for just five streams.

Poso Creek. Poso Creek, the only minor stream with an appreciable annual basin inflow, enters the Valley approximately 19 km (12 miles) north of Bakersfield. The earliest flow records for this stream were made by the Kern County Land Company at the Mons Station, 26 km (16 miles) upstream from Highway 99 (as Section 9, T28S/R29E, MDB& M). They cover the period between 1945 and 1964.

The U. S. Geological Survey established a gaging station at First Point in 1960, and since then data have been recorded annually at this location.

Most oil field waste waters (a major fraction of this stream's inflow) enter Poso Creek downstream from the Mons and First Point stations and are therefore not included in their records. The waste waters, which enter the creek near the Highway 155 bridge, averaged 9 600 000 m^3 (7,800 acre-feet) per year during the base period, and by 1968 the annual supply had risen to 32 hm^3 (26,000 acre-feet).

The quantity of oil field waste water delivered to Poso Creek is now regulated by controls placed on the quality of discharges to the basin. Future waste water projections will reflect this change in water supply.

Surface flow gages have been maintained by the Kern County Land Company (now Tenneco West) and the North Kern Water Storage District on Poso Creek at Highway 99, about 16 km (10 miles) downstream from the eastern boundary of the basin model, and on the Wasco-Pond Highway, 9.7 km (6 miles) west of Highway 99.

Ground water recharge from Poso Creek runoff and oil field waste water were calculated after comparing and analyzing all gaging station data. The records from the stations are shown in Table 22 (Appendix B).

San Emigdio Creek. The U. S. Geological Survey has compiled records for San Emigdio Creek (Township 11 north, Range 22 west, San Bernardino Base and Meridian) runoff, beginning in March 1959. The average surface flow for the 1960-69 period was approximately 1 360 000 m^3 (1,100 acre-feet) per year, a large portion of which was absorbed by the moisture-deficient soils as it entered the model area.

Caliente Creek. Caliente Creek runoff has been recorded since October 1961 at a point 2.7 km (1.7 miles) west of Caliente (T30S/R31E, MDB & M). The annual runoff since 1962, excluding Walker Basin Creek water that enters the stream below the gaging station, has averaged 2 606 000 m^3 (2,113 acre-feet) per year. Records cover only five years of the nine-year base period. The calculated average from that period is 1 277 000 m^3 (1,035 acre-feet) per year.

Water from Caliente Creek reached the model area in 1966, when an estimated 12 300 000-m^3 (10,000-acre-foot) flow entered the Valley. Since only 1 124 000 m^3 (911 acre-feet) of flow was recorded at Caliente Creek that year, it is assumed that nearly all the water came from Walker Basin Creek.

Tehachapi Creek. The seven-year recorded average flow for Tehachapi Creek (1963 through 1969) is 229 000 m^3 (186 acre-feet) per year. This stream also enters Caliente Creek below the gaging station. During the 1969 flood, Tehachapi Creek flow was recorded as 1 290 000 m^3 (1,050 acre-feet).

Pastoria Creek. Records of flow in Pastoria Creek (T10N/R19W, SBB & M) were begun in October 1964 and averaged 770 000 m^3 (624 acre-feet) per year.

Other Minor Streams. Fourteen other minor streams with limited or no flow records were examined, and inflow from the drainage areas of each was estimated. The inflow was estimated for each of the nine base-period years by correlation with measured inflow of Caliente and San Emigdio Creeks.

The estimated inflow for the streams listed below is presented in Table 22 (Appendix B).

Santiago Creek	T11N/R23W, SBB&M
Los Lobos Creek	T11N/R22W, SBB&M
Pleito Creek	T11N/R21W, SBB&M
Salt Creek	T10N/R20W, SBB&M
Tecuya Creek	T11N/R20W, SBB&M
Grapevine Creek	T11N/R19W, SBB&M
El Paso Creek	T11N/R18W, SBB&M
Tunis Creek	T11N/R18W, SBB&M
Tejon Creek	T32S/R29E, MDB&M
Chanac Creek	T11N/R17W, SBB&M
Comanche Creek	T32S/R30E, MDB&M
Caparell Creek	T11N/R18W, SBB&M
Little Sycamore Creek	T32S/R29E, MDB&M
Sycamore Creek	T31S/R30E, MDB&M

These surface flows during the base period were distributed to the appropriate nodes of the ground water grid after making adjustments for deep percolation losses along the flow route. Only the water remaining on the ground surface as it crossed the exterior boundary of the model was counted as minor stream input to the surface water inventory.

Imported Water

Only the Friant-Kern Canal was importing water to the study area during the 1958-66 base period, although the California Aqueduct deliveries (which began in 1968) are of major consequence in hydrologic projections for the model area.

Friant-Kern Canal. The Friant-Kern Canal, a component of the Federal Central Valley Project, is a major facility that delivers municipal, industrial, and agricultural water to the eastern edge of the San Joaquin Valley.

Four districts in Kern County have long-term contracts for firm and surplus water supplies from the system -- Delano-Earlimart Irrigation District, Southern San Joaquin Municipal Utility District, Shafter-Wasco Irrigation District, and Arvin-Edison Water Storage District. Other agencies occasionally receive surplus waters from the Friant-Kern Canal.

Friant-Kern Canal water was first delivered to Delano-Earlimart ID in 1950, to Southern San Joaquin MUD in 1951, to Shafter-Wasco ID in 1957, and to Arvin-Edison WSD in 1966.

Total Friant-Kern deliveries to Kern County during the base period are shown in Tables 3 and 4 along with itemized deliveries since that time to the respective districts.

TABLE 3

LONG-TERM CONTRACTORS AND
FRIANT-KERN CANAL DELIVERIES TO KERN COUNTY
(in acre-feet)

Calendar Year	Delano-Earlimart ID 1/	South San Joaquin MUD	Shafter-Wasco ID	Arvin-Edison WSD
1950	800			
1951	4,700	22,300		
1952	9,100	40,400		
1953	10,200	72,200		
1954	13,700	94,900		
1955	19,000	105,900		
1956	24,100	124,000		
1957	22,700	114,900	2,100	
1958	21,100	101,300	32,900	3,000
1959	21,200	101,600	42,500	0
1960	15,400	94,700	45,900	0
1961	12,200	76,600	36,200	0
1962	23,000	127,700	46,000	0
1963	22,700	124,500	45,300	0
1964	17,900	114,600	55,100	0
1965	23,700	131,500	50,300	100
1966	18,500	114,300	50,800	38,900
1967	22,700	129,800	51,400	70,500
1968	15,000	92,600	44,100	54,600
1969	20,700	115,600	47,800	176,800
1970	20,800	129,700	57,300	143,000
1971	19,400	116,400	55,500	141,100

1/ These figures represent 14 percent of total deliveries to district; remainder of deliveries went to Tulare County portion of district.

California Aqueduct. Since there were no deliveries to the Kern County area from the California Aqueduct during the base period, this source did not affect the water inventory.

The imports from the aqueduct are now a major item in the basin hydrology, however, and estimated future deliveries of State Water Project water are shown on Figure 3.

Actual deliveries of water are increasing at an annual rate exceeding that of these estimates, and it is anticipated that the maximum allocations will first reach Kern County during 1981.

TABLE 4

SHORT-TERM CONTRACTORS AND
FRIANT-KERN CANAL DELIVERIES TO KERN COUNTY
(in acre-feet)

Calendar Year	Alpaugh ID	Buena-Vista WSD	Rag Gulch WD 1/	Rosedale-Rio Bravo WSD	County of Kern	Kern County Water Agency	PG & E Power Plant	Operations and Wasteway Spills and Others
1958	3,000	52,300	3,300		7,000 2/		2,900	7,400
1959	0	0	0				0	500
1960	0	0	0				0	3,200
1961	0	0	0				0	800
1962	0	15,700	3,000	9,800			0	500
1963	0	19,700	4,900	15,900			1,300	700
1964	0	0	500	0			1,200	1,300
1965	0	27,700	3,300	8,800			100	40
1966	0	3,000	200	4,900		0	1,500	200
1967	6,000	8,500	5,700	15,000		13,000 3/	3,000	9,200
1968	700	0	300	0		0	0	100
1969	6,900	0	5,600	0			0	17,300
1970	800	9,500	600	0			0	1,900
1971	300	8,000	0	8,400			0	0

1/ These figures represent 55 percent of total deliveries to district; remainder went to Tulare County portion of district.

2/ Delivered to Lake Woollomes.

3/ Delivered to Kern River channel.

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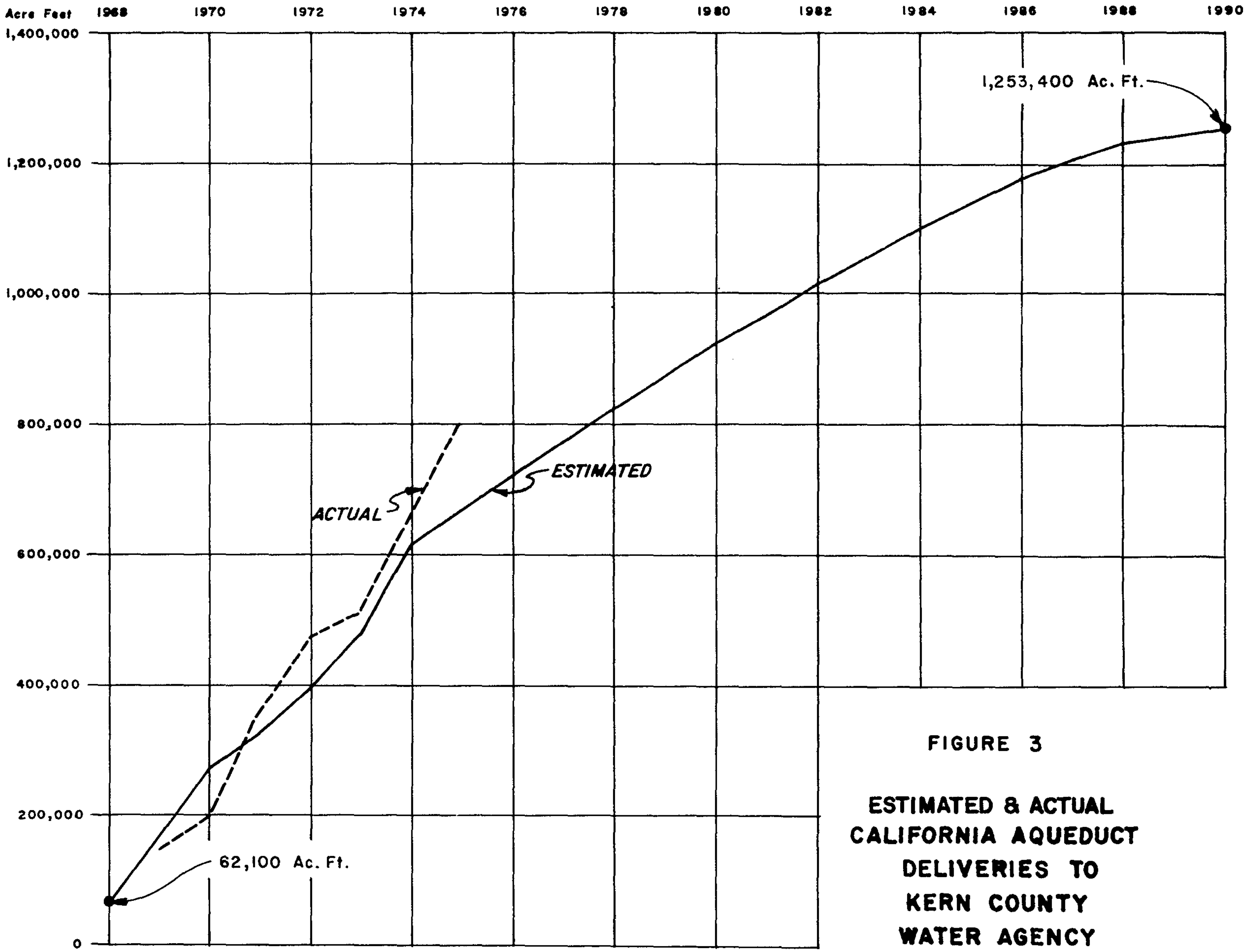

FIGURE 3

ESTIMATED & ACTUAL CALIFORNIA AQUEDUCT DELIVERIES TO KERN COUNTY WATER AGENCY

C-040678

Surface Water Outflow

No surface water outflow from the model area was recorded during the base period, although during extremely wet years the Kern River flows -- and possibly some flow from Poso Creek -- move northward into Kings County.

Kern River Outflow

In normal years, all Kern River water is diverted into canals for irrigation use. During extremely wet years, water historically flowed into Jerry Slough and followed the old channel northward through Goose Lake and Goose Lake Slough to Tulare Lake in Kings County.

High water sometimes reaches Buena Vista Lake when the river channel cannot hold the flows. Excess water from the lake is usually diverted into the flood canal and sent along the old Kern River route, where portions of water are diverted into a system of sloughs and waterways, while the main flow moves north to Tulare Lake.

The annual river outflow has averaged approximately 86 hm^3 (70,000 acre-feet), but the volume was reduced in 1954 with construction of Isabella Dam.

Buena Vista Water Storage District records of surface flow at Highway 46, about 4 km (2.5 miles) east of Lost Hills and approximately 19 km (12 miles) south of the northern Kern County boundary, are shown in Table 5.

TABLE 5

KERN RIVER FLOW AT HIGHWAY 46

Water Year[1/]	Acre-feet
1936-37	252,200
1937-38	393,600
1940-41	441,600
1941-42	109,800
1943-44	454,300
1951-52	210,200
1954 - Isabella Dam constructed	
1969-70	315,700
14-year mean (1954-69)	22,500

1/ No flows during other years.

Poso Creek Outflow

Poso Creek surface runoff is normally contained in the improved natural channel of Poso Canal and its associated facilities. During extremely wet years, it is probable that excessive runoff flows northward across the county boundary, but no such instances have been documented. In 1958, flood waters nearly reached the County's northern boundary in T25S/R23E, MDB & M. An estimated 25 hm^3 (20,200 acre-feet) of Poso Creek water was reportedly diverted for use in the Kern National Wildlife Refuge during the 1969 flood period.

Streamflow Diversions

Streamflow diversion in the model area is defined as any unnatural form of streamflow transportation, including pipes, ditches, or canals.

Kern River Diversions

Diversion of all Kern River flow, except that resulting from storm or flood-stage runoff, is specified under the Miller-Haggin Agreement of 1888. Under that agreement, Kern Island Irrigating Canal Company acquired rights to the first 8.5 m^3 (300 cubic feet) per second of flow throughout the year. From March through August, the Miller interest received one-third of the remaining flow measured at the First Point gaging station. That water was to be delivered at the Second Point of measurement, about 32 km (20 miles) downstream of Bakersfield. The other two-thirds of the remaining flow was assigned to the Haggin interests.

From September through February, any water in excess of the 8.5 m^3/s (300 cfs) above the Second Point went to the Haggin interests. The Miller interests were granted rights to all water passing Second Point.

All of the diverted water is for agricultural use, and the rights are held by the original entities or their heirs or assigns.

Classification of the Kern River diversions is now made according to the point at which the entitlement is measured.

The First Point group includes canal companies and districts formerly owned by or associated with the Kern County Land Company (now Tenneco West). The Second Point group is the Buena Vista Water Storage District and its associates. Lower river interests include Tulare Lake Basin Water Storage District and Hacienda Water District.

During the 1969 flood period, a one-time diversion of Kern River flow was made through the California Aqueduct to the Lost Hills Water District and the Belridge Water Storage District. Of the total Kern River flood flow of 2 854 hm^3 (2,313,800 acre-feet) (measured at First Point), 111 hm^3 (90,100 acre-feet) was diverted through use of the aqueduct to the districts.

Poso Creek Diversions

Annual diversions of approximately 1 400 000 m^3 (1,100 acre-feet) of Poso Creek flow was made during the base period for use by farmers outside the model area. The remaining portion of surface runoff in the model area was used by individuals and companies with agricultural water conveyance systems located near the Poso Creek channel.

During flood-stage runoff years, Poso Creek water is sometimes diverted through canal and ditch systems to the Kern National Wildlife Refuge. There, it is impounded and used either for recreation or to grow crops for waterfowl feed.

Minor Stream Diversions

Minor streams entering the basin provide a sporadic water supply that usually percolates from the stream channels to recharge ground water reservoirs. Some of this water is diverted for surface spreading over agricultural areas during high runoff years.

Determination of Seasonal and Effective Precipitation

The valley portion of Kern County receives slight rainfall, with annual averages from various stations ranging from 130 to 230 millimetres (5 to 9 inches) -- resulting in an annual average of approximately 150 mm (6 inches) for the entire area.

Normal rainfall produces no runoff over most of the Valley and only limited runoff in other areas. During wet years, however, sheet flow sometimes develops over large areas on the Kern River fan and overflow areas. The flows produce local erosional cuts and fill sloughs and ditches created by previous storms.

Local runoff during 1969 contributed an estimated 18 hm^3 (15,000 acre-feet) of water to the Kern River runoff passing Highway 46 near Lost Hills.

Weighted Average Precipitation

A perusal of precipitation records from seven stations in the ground water basin area (shown in Plate 4) revealed that the amount of rainfall is controlled by localized weather conditions. Because of wide variations in monthly precipitation during the 1958-66 base period, it was concluded that a weighted average factor should be developed and applied to recorded data for all areas in the study through use of the Thiessen polygon method (Thiessen, 1911).

Precipitation records for each station are shown in Table 23 (Appendix B).

Combined monthly precipitation data for the base period from each recording station were adjusted to establish a weighted mean rainfall total for monthly application to all areas under study. This average precipitation supply was made available to satisfy a portion of the consumptive use requirement of crops growing during that period. The weighted monthly areal precipitation for the model area is presented in Table 24 (Appendix B).

Effective Precipitation

Many hydrologists consider rainfall in an arid area an asset to the water accounting system only if the annual rainfall exceeds 200 mm (8 inches). Others consider only the amount of precipitation that contributes at least 13 mm (.5 inch) of rain in a given storm.

Effective precipitation is defined for this study as the amount of rain that falls during the growing season of major crops. It is assumed that this amount of effective precipitation will replace an equal amount of water that would normally be supplied to meet the agricultural demand at that time. It is estimated that this annual contribution to the water supply averages 162 hm^3 (131,600 acre-feet).

The growing season for all major crops in Kern County was determined, and the estimated monthly consumptive use requirement of each crop was recorded for this study. It was then assumed that rainfall that satisfied a portion of these monthly consumptive use requirements should be considered effective precipitation.

Annual effective precipitation in the basin area was calculated for the 1958-66 base period by multiplying the irrigated acreage assigned to each major crop by the estimated effective precipitation during the respective growing seasons. The total effective precipitation for each year including amounts determined for all major crops is presented in Table 25 (Appendix B).

It was assumed that all nodal areas of the ground water model were large enough (each is 23 km^2 -- 9 square miles -- in area) to produce their proportionate share of major crops affected by this precipitation.

Unit Effective Precipitation

By definition, total effective precipitation used by all crops is the total effective precipitation available to crops during the growing season. This total volume was made available to the model's nodal area through a "unit effective precipitation" determined each year by dividing the total effective precipitation by the total irrigated acres reported for that year. This unit effective precipitation was then multiplied by the total irrigated acres in each nodal area to determine the total effective precipitation for each year considered. A summary of effective precipitation totals for the entire study area is given in Table 6.

TABLE 6

EFFECTIVE PRECIPITATION
MODEL STUDY AREA

Year	Unit EP (acre-feet per acre)	Area (acres)	Total EP (acre-feet)
1958	0.39	598,000	236,200
1959	0.13	608,000	79,300
1960	0.17	616,000	105,400
1961	0.08	626,000	50,400
1962	0.23	635,000	147,000
1963	0.35	645,000	227,000
1964	0.14	655,000	92,200
1965	0.27	665,000	179,100
1966	0.10	674,000	67,800
Average 1958-66	0.21		
1969	0.23	737,000	169,500
1971	0.18	750,000 1/	135,600

1/ Data from NASA flight information.

Effective Precipitation and Kern River Flow

There appears to be a direct correlation between annual total effective precipitation and Kern River flow at the First Point of measurement. During the base period the ratio

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of effective precipitation to river flow varied from a maximum of 32 percent in 1960 to a minimum of 13 percent in 1966. The average ratio was 26 percent.

Effective precipitation totals for the study period were within 5 percent of the reported average during six of the nine years. This correlation suggests that estimates of effective precipitation can be based on recorded Kern River flow at First Point, modified by the 26-percent average ratio factor.

Waste Water

Municipal waste water treatment plants and industrial operations are the primary sources of waste water in the study area. Waste water input to municipal treatment plants increased during the base period, going from 24 hm^3 (19,800 acre-feet) per year to 28 hm^3 (23,000 acre-feet) per year. Oil field waste water conveyance losses, percolation, and agricultural recharge averaged approximately 6 800 000 m^3 (5,500 acre-feet) per year.

Municipal Waste Water

A portion of Kern County's waste water is reclaimed through use of treated effluent from municipal waste water treatment plants for percolation from spreading ponds and irrigation of agricultural lands.

Ground water recharge is also accomplished through privately owned disposal systems associated with industrial plants, such as food processing and packing sheds.

Municipal treatment plants were operated by the cities of Delano, McFarland, Wasco, Shafter, Bakersfield, Weedpatch-Lamont, and Arvin during the base period. Amounts of waste water input to each of these systems (along with the respective populations contributing to each supply) are shown in Table 26 (Appendix B) and summarized in Table 7. Population figures were taken from a straight-line projection of data found in 1960 and 1970 federal census reports. Waste water totals are from reports on individual plants or per capita estimates based on historical data.

A review of statistics from sewered areas reveals that it would be reasonable to apply per capita waste figures to determine the approximate volume of sewage disposed through septic tanks and other private systems. The difference between a designated area's predicted volume of sewage and the actual amount received by the area's municipal treatment plant is

TABLE 7

MUNICIPAL WASTE WATER
TREATMENT PLANT INPUT

Year	Population	Waste Water (acre-feet)
1958	189,148	19,800
1959	192,362	20,200
1960	196,360	21,100
1961	199,046	20,400
1962	202,372	21,100
1963	205,697	21,800
1964	209,025	22,300
1965	212,350	22,300
1966	215,584	24,000
1967	216,474	24,700
1968	223,167	25,800
1969	226,320	27,100
1970	229,871	26,700
1971	232,866	27,900
1972	236,097	28,500
1973	239,403	28,900
1974	243,827	31,400
1975	250,565	32,200
1976	252,620	32,800

assumed to represent the volume handled by private systems. This volume was assigned to the deep percolation category of the water accounting system.

In order to properly distribute sewage effluent to the ground water model, it was necessary to identify each municipal treatment facility with a nodal subdivision of the populated area. This item of supply is designated "sewage" in the agricultural water sources summary.

Estimates of future sewage supplies for each municipality were made by multiplying the population's water demand by an empirically derived factor designed to calculate the total sewage available. Distribution of effluent to individual nodes was accomplished on a percentage basis by applying another empirically derived factor.

Oil Field Waste Water

Oil field waste waters contribute to the ground water inventory through percolation from sumps, spreading areas, and other recharge facilities.

As shown in Table 8, conveyance losses, deep percolation, and agricultural recharge from this source increased steadily during the base period.

TABLE 8

CONVEYANCE LOSS, DEEP PERCOLATION, AND AGRICULTURAL RECHARGE OF OIL FIELD WASTES (in acre-feet)

Year	Conveyance Loss and Deep Percolation	Agricultural Recharge
1958	2,800	2,300
1959	2,800	2,300
1960	2,800	2,300
1961	2,900	2,300
1962	2,900	2,300
1963	2,900	2,500
1964	3,000	2,600
1965	3,000	2,800
1966	3,200	3,300
Average 1958-66	2,900	2,500
1972		4,700

Statistics shown in Table 8 are from the files of the California Division of Oil and Gas. A more detailed summary of the oil field waste discharges is given in Tables 27 and 28 (Appendix B).

In July 1968, the Getty Oil Company completed a water recycling plant designed to clean and soften waste water produced with the oil from the Kern River field. By September 1972, the plant was daily processing 63 600 m^3 (51.6 acre-feet) of water, of which approximately 47 700 m^3 (38.7 acre-feet) was used daily in the oil field recovery process and about 15 900 m^3 (12.9 acre-feet) per day, or 5 800 000 m^3 (4,700 acre-feet) per year, was discharged into the Beardsley Canal for delivery to farmlands.

For years, most of the Poso Creek flow has consisted of oil field waste water. As a result of increased accumulations of chemicals in the ground water basin, the California Regional Water Quality Control Board placed limitations on the allowable chemical quality of discharges. It is expected that the new limitations will force oil field operators to find other waste water disposal sites, a move that will affect the basin's water balance.

Waste water produced by each oil field was distributed to ground water nodes by inspection of oil sump locations. In the case of percolation, it was assumed that the fluid was evenly divided among several ponds associated with each field. Since about half the impounded water evaporates, only half the reported supply was considered a conveyance loss to deep percolation.

Agricultural Waste Waters

Agricultural waste waters have not been reclaimed for reuse or removed by export facilities (evaporation ponds are being considered for a local disposal system). Some of this water is accumulating in low-lying areas, and eventually these concentrations and new annual accumulations will have to be removed from the Valley if lowland farming is to continue.

Artificial Recharge of Fresh Water

During the base period, four agencies in the model area were engaged in artificial recharge of the ground water basin -- two of them only in the final years of the 1958-66 period. In addition, flood stage waters from the Kern River and other model area streams are diverted to recharge locations by a number of canal companies and agricultural interests. Recharge areas are shown in relation to the nodes in the model in Plate 5.

Besides the deliberate recharge operations, canal conveyance losses and deep percolation from over-irrigation contribute substantially to ground water recharge in the model area.

Kern County Land Company (Tenneco West)

For years, Kern County Land Company (now Tenneco West) has spread surface water for ground water recharge in the North Kern Water Storage District. The program uses water from Kern River and Poso Creek whenever available.

Records from the Company's spreading ponds in T26S/R25E, T27S/R25E, and T28S/R26E, MDB & M, predate all others in Kern County. Amounts of recharge by the Company and the nodes to which it was allocated are shown in Table 9.

Rosedale-Rio Bravo Water Storage District

Rosedale-Rio Bravo Water Storage District has spread surplus Friant-Kern Canal water along with its annual allocation of Kern River water since 1962. The system consists of

TABLE 9

GROUND WATER RECHARGE
NORTH KERN WATER STORAGE DISTRICT
(in acre-feet)

Year	Node 46	Node 63	Node 87	Node 93	Total
1958	28,300	28,100	30,500	25,200	112,100
1959	2,500	2,500	2,700	2,700	10,500
1960	4,600	4,600	4,900	4,900	18,900
1961	1,100	1,100	1,200	1,100	4,400
1962	6,600	6,100	7,100	7,100	27,000
1963	13,800	13,800	15,000	14,600	57,200
1964	800	800	900	900	3,500
1965	7,100	7,100	7,700	7,600	29,500
1966	3,300	3,300	3,600	3,600	13,800
Average 1958-66	7,600	7,500	8,200	7,500	30,800

a headworks and diversion structure on the Kern River, a canal to transport water to the old Goose Lake Slough, about 16 km (10 miles) of channel, four recharge basins totaling 911 000 m^2 (225 acres) near the western edge of the project, and two recharge basins totaling 93 000 m^2 (23 acres) near the eastern edge of the project.

Between 1962 and 1971, recharge operations in the system spread a total of 535 hm^3 (433,366 acre-feet) of water -- an average of 56 hm^3 (45,600 acre-feet) per year. In addition, Rosedale-Rio Bravo WSD expects to spread nearly all of its 43-hm^3 (35,000-acre-foot) annual entitlement from the California Aqueduct for ground water recharge. Details of the sources and amounts spread by Rosedale-Rio Bravo WSD are supplied in Table 10.

Arvin-Edison Water Storage District

Arvin-Edison Water Storage District began spreading operations in 1966 with a system that included two spreading works operating in conjunction with well field extractions to convert an irregular imported water supply to firm delivery service for its users.

Between 1966 and 1973, Arvin-Edison WSD recharged a net total of 251 hm^3 (203,600 acre-feet) of water -- an annual average of 36 hm^3 (29,100 acre-feet).

TABLE 10

GROUND WATER RECHARGE
ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT
(in acre-feet)

Year	Source of Supply: Friant-Kern Canal	Kern River	California Aqueduct	Total
1962	9,900	1,400	--	11,300
1963	19,700	64,900	--	84,600
1964	0	15,300	--	15,300
1965	8,600	57,600	--	66,200
1966	5,400	15,500	--	20,900
1967	13,000	73,300	--	86,300
1968	0	24,400	--	24,400
1969	0	82,300	--	82,300
1970	0	21,900	3,900	25,800
1971 1/	8,400	8,000	--	16,400
Average 1962-71 2/	6,800	38,400	--	45,600

1/ Through June 1971.
2/ Calculated for 9.5 years.

Arvin-Edison WSD's Sycamore spreading works includes a 1 600 000-m^2 (390-acre) plot on an alluvial fan of Sycamore Creek (T31S/R30E, MDB&M) and a nearby field of 30 wells. The Tejon spreading works is on Tejon Creek, about 10 km (6 miles) south of the Sycamore facility in T32S/R29E, MDB&M. It covers an area of 2 090 000 m^2 (516 acres) and has 20 wells.

Arvin-Edison WSD's wells deliver a minimum of 0.1 m^3/s (4 cfs) from depths ranging from 140 to 170 metres (450 to 560 feet) below the pump base elevation. The wells range in depth from 229 to 329 metres (750 to 1,078 feet). A summary of Arvin-Edison WSD's percolation and withdrawal activity is shown in Table 11.

Future use of the Arvin-Edison WSD percolation facilities will vary with the amount of Friant-Kern Canal water deliveries to the sites. Arvin-Edison WSD's water service contract provides for delivery of up to 49 hm^3 (40,000 acre-feet) per year of water on a firm supply basis and up to 386 hm^3 (313,000 acre-feet) annually of Class II water.

It has been estimated that total annual deliveries to Arvin-Edison WSD will average 236 hm^3 (191,000 acre-feet), ranging from 33 hm^3 (27,000 acre-feet) in a dry year to a

TABLE 11

GROUND WATER RECHARGE
ARVIN-EDISON WATER STORAGE DISTRICT
(in acre-feet)

Reporting Year (March-February)	Percolated Water	Extracted Water	Net Ground Water Storage Change
1966-67	41,400	0	41,400
1967-68	63,700	0	63,700
1968-69	5,500	11,400	-5,900
1969-70	107,800	400	107,400
1970-71	28,000	100	27,900
1971-72	44,200	100	44,100
1972-73 1/	0	75,000	-75,000

1/ Includes projected amounts for period August 1972 through February 1973.

maximum of 435 hm^3 (353,000 acre-feet) in a wet year. In years when the average 236-hm^3 (191,000-acre-foot) delivery is made, approximately 101 hm^3 (82,000 acre-feet) will be percolated, and the remaining 134 hm^3 (109,000 acre-feet) will be delivered directly to the service area. On the average, about 86 hm^3 (70,000 acre-feet) will be extracted each year from the ground water basin through the well fields to sustain service area deliveries.

West Kern County Water District

West Kern County Water District maintains a well field in Sections 21 and 28, T30S/R25E, MDB&M, to meet its municipal and industrial needs. Extractions from the field have been classified as ground water exports in the model's terminology. Recharge operations near the well field were begun in 1965 when 7 400 000 m^3 (6,000 acre-feet) of Kern River water was spread for that purpose. West Kern County WD spread 9 200 000 m^3 (7,500 acre-feet) in 1966, 18 hm^3 (14,400 acre-feet) in 1967, and 2 500 000 m^3 (2,000 acre-feet) in 1968.

It is expected that all of West Kern County WD's annual entitlement (31 hm^3, or 25,000 acre-feet) from the California Aqueduct will be used for recharge of the ground water basin. The Taft area supply will be exported from this entitlement.

Recharge from Over-irrigation

Recharge of the ground water basin from over-irrigation of agricultural land occurs in all districts overlying the ground water basin. In some areas, however, the presence of moisture-deficient soils and/or perched water conditions interrupts -- at least temporarily -- this deep percolation flow.

It is estimated that at least 26 to 32 percent of the water applied to crops passes through the root zone as deep percolation. With the import of more expensive water and the use of more efficient water management practices, it has been estimated that this percolation will be reduced to approximately 20 percent.

Leakage from surface transmission facilities has been classified as conveyance loss attributable to deep percolation and is considered a contribution to the ground water recharge inventory. These amounts (along with those of deep percolation resulting from irrigation) averaged 785 hm^3 (636,700 acre-feet) per year during the base period. They are shown in Table 12.

TABLE 12

DEEP PERCOLATION TO GROUND WATER 1/
(in acre-feet)

Year	Irrigation	Conveyance Loss	Total
1958	373,200	99,000	472,200
1959	591,400	76,200	667,600
1960	561,800	68,900	630,700
1961	647,300	51,600	698,900
1962	526,800	101,800	628,600
1963	422,500	123,200	545,700
1964	619,900	84,300	704,200
1965	512,500	113,000	625,500
1966	664,700	91,600	756,300
Average 1958-66	546,700	90,000	636,700

1/ Data were taken from Computer Run No. 18. Agricultural deep percolation was computed by subtracting consumptive use and moisture-deficient soil requirements from agricultural demand.

Population of Model Area

Kern County's population rose from 291,984 in 1960 to 329,162 in 1970 -- an annual increase of 3,718 over the ten-year period, a rate of about 1.3 percent per year. The urban Bakersfield area accounted for 25,418 people, or 68.5 percent of the total increase.

Population changes in the County as well as a population projection through the year 2000 are shown on Figure 4.

Assignment of Population to Nodes

Census tract data were assigned to ground water model system nodes in the urban Bakersfield area. It was then possible to determine the rate of change in population of each node from one census to the next. This information is tabulated in Table 29 (Appendix B).

The same procedure was used to establish nodal populations for the cities of Delano, McFarland, Wasco, Shafter, Buttonwillow, Weedpatch-Lamont, and Arvin in the County's ground water basin area. A straight-line projection of 1960 and 1970 data was made for all nodes involved to establish population trends for projections and for use during the base period.

The ground water model is programmed to total the population of appropriate nodes in each community to establish municipal populations from which water demands can be computed. Population input for the model work is shown in Table 30 (Appendix B). Future water demand projections will require the definition of nodal populations for the period in question.

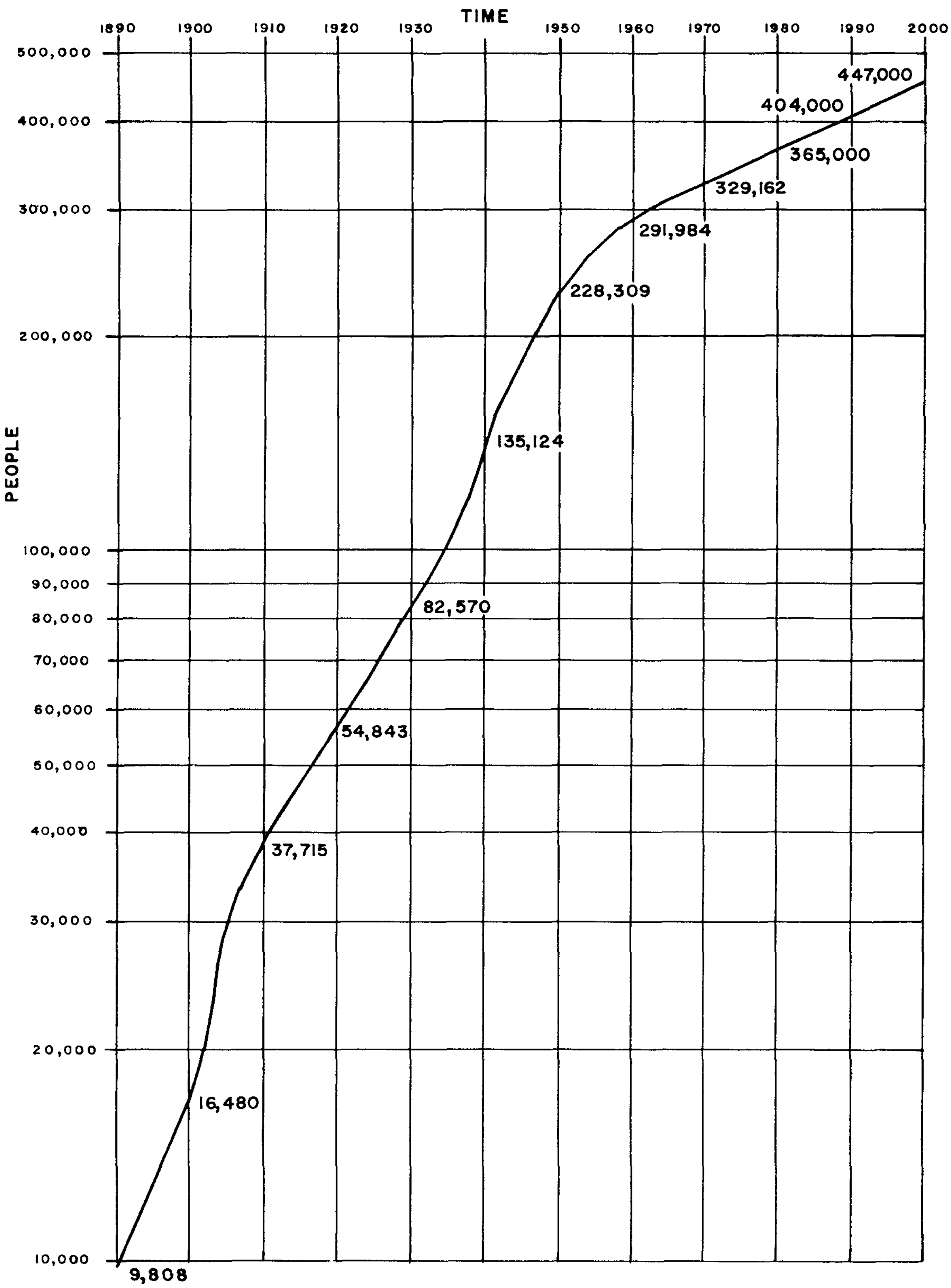
The City of Taft lies outside the ground water basin and is not included in the tabulation shown in Table 30. Because it receives its water through the West Kern County Water District from wells within the model area, Taft's demand was considered exported ground water. The 1970 census shows the population of Taft and its suburbs to be 12,206, a decrease of 230 from the 1960 census. The industrial water demands of the Taft area are related to oil field activity rather than population and must therefore be considered independently when exports are projected.

Land Use in Model Area

Three land use or crop surveys of the Kern County ground water basin were used to establish a basis for projections of irrigated land use for the model study.

FIGURE 4

KERN COUNTY POPULATION PROJECTION



SOURCE: US CENSUS — FROM THE KERN COUNTY PLANNING DEPT. (1971)

The surveys included (1) a 1958 land use survey conducted by the Department and involving the mapping of land use in the field on photographs; (2) a 1966 Department survey of changes in irrigated acreage, covering the same area as the 1958 survey; and (3) a complete Department land use survey conducted in 1969 and accomplished through interpretation of current aerial photography supplemented by field inspections.

Consumptive Use Calculations

The 1958 land use was examined in detail, and appropriate acreages were transferred to the model's nodal system. A weighted average of crop consumptive use was established for each node so that a unit consumptive use factor could be applied to the annual irrigated acres in future years to compute each nodal area's total consumptive use.

A straight-line projection of irrigated acreage was made from 1958 through 1966 to establish an estimate for the intervening years for use in model calculations.

The 1969 land use survey established a consumptive use pattern for the final years of the base period by providing details of individual crop information. A computer evaluation of crop survey information permitted rapid distribution of crop data to appropriate nodal areas.

Additional comparative agricultural information was obtained from annual agricultural crop reports prepared by the Kern County Department of Agriculture. These reports summarize reported crop acreages and list changes and trends; but since they cover the entire County and are restricted to input reported by various field representatives, interpretations of acreage distribution are necessary before the data can be applied to the County's ground water basin.

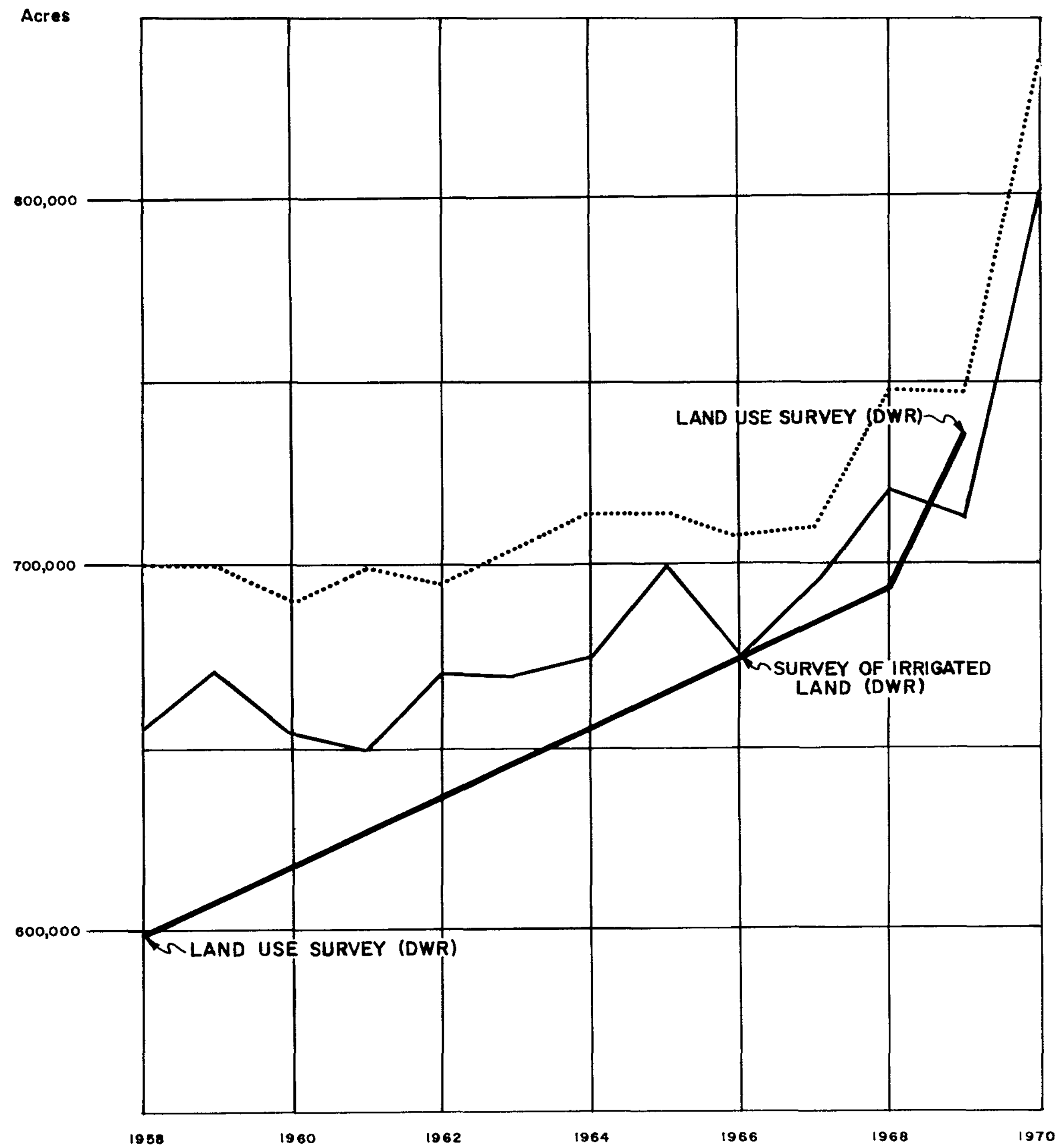
A graphic summary of all agricultural land use during the base period (extending through 1970) is offered on Figure 5. The same graph indicates the County's total number of harvested and irrigated acres.

Irrigated Land Projections

Projections of irrigated land use were made by the Department in an unpublished district report entitled "Economic Demand for Water -- Area I, Kern County-Tulare Lake Basin", dated July 1967. Estimates of irrigated land development for major crops are given in Table 31 (Appendix B) of this study.

FIGURE 5

KERN COUNTY AGRICULTURAL ACREAGE



HARVESTED ACREAGE, COUNTY } FROM KERN COUNTY CROP REPORTS
IRRIGATED ACREAGE, COUNTY }
IRRIGATED ACREAGE, GROUND WATER BASIN AREA

C —0 4 0 6 9 5

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A 1956 Kern County land classification study conducted by the Department identified 654 800 hectares (1,618,000 acres) of land suitable for irrigated crop production. Some of this acreage has limited use, and because of high water tables and excessive salt concentrations, a large portion of this land must ultimately be leached and drained if it is to remain productive.

Table 13 lists potential land uses and estimates the maximum land available for irrigated agricultural development after 2020. Without creation of a long-term overdraft of the ground water basin, the ideal maximum agricultural acreage is limited by the available water supply.

TABLE 13

ULTIMATE IRRIGABLE LANDS
GROUND WATER BASIN AREA OF KERN COUNTY
(in thousands of acres)

1956 Survey	Non-agricultural Lands	Agricultural Lands
Nonirrigable	32.4	
Urban use	85.1	
Suitable for all crops		640.0
Limited use		978.2
Totals	117.5	1,618.2
1970 estimated area with present and future drainage problems		200.0
Ultimate total lands without drainage plan		1,418.8

It is estimated that the combined water supply from the California Aqueduct, the Friant-Kern Canal, ground water yield equal to natural recharge, and effective precipitation will total 2 995 hm^3 (2,428,000 acre-feet) in 1990. After subtracting 18 percent as the amount required to maintain a salt balance in the area, a net 1990 water supply of 2 456 hm^3 (1,991,000 acre-feet) is available for use.

With a consumptive use of 0.8 m^3/m^2 (2.6 acre-feet per acre), the calculation yields an ideal maximum irrigated acreage of 311 300 ha (769,200 acres).

Curiously, the computed ideal 1990 irrigated agricultural land development is approximately 24 000 ha (60,000 acres) less than the 1974 irrigated land development in the 335 000-ha (829,000-acre) nodal area, as calculated from NASA U-2 aerial photographs. The same source indicates an irrigated acreage of 372 000 ha (920,000 acres) for the San Joaquin Valley portion of the County.

It should be noted, however, that yield and salt balance figures used in these calculations are only estimates and are subject to change as more information is gathered.

Irrigation Efficiency

Irrigation efficiency is defined here as the relationship between evapotranspiration and applied water. At an irrigation efficiency of 100 percent, no water is lost (either to deep percolation or surface runoff), since the entire amount of applied water is used consumptively. This situation would permit salts to accumulate in the root zone, resulting in reduced crop yields. Hence, a leaching factor is added to the required consumptive use supply in planning the total water demand.

This practical approach to land management was considered when ground water model factors were developed. A study conducted in California by Iowa State University (1970) revealed a direct relationship between crop type and irrigation efficiency employed. The results of the study are given in Table 14.

TABLE 14

ASSUMED IRRIGATION EFFICIENCIES OF VARIOUS CROPS

Crop	Irrigation Efficiency (percent)
Alfalfa	75
Clover	60
Pasture	70
Grains and silage	70
Cotton	70
Vegetable	65
Rice	65
Sugar beets	65
Citrus and nuts	75
Subtropical fruits and vines	75

The irrigation efficiencies given in Table 14 were applied to crops grown in the nodal areas, and a weighted average irrigation efficiency was derived for each area. During a ground water simulation run, these factors were used to determine the amount of deep percolation resulting from applied irrigation water. They can also be used to calculate the total water demand for irrigated acreage.

Consumptive Use of Water

Water used consumptively in agriculture includes water consumed by vegetative growth and associated evaporation -- the process normally termed evapotranspiration. It also includes water evaporated from adjacent soil during the evapotranspiration process.

Urban consumptive use calculations include the amount of water consumed (or evaporated) and thereby removed from the total water inventory. It is customary to relate the total community consumptive use to population and to define a unit of consumptive use per capita.

Recreational use includes all water consumed in the operation of recreational facilities -- primarily waterfowl hunting sections of the study area.

Vegetative Consumptive Use

Unit consumptive use values for all agricultural land covered in this study were established by the Department of Water Resources through evaporative demand and crop studies conducted in the Tulare Lake Basin.

Eight crop categories were employed for this study, and it was noted that water demands for individual crops differed considerably within the field, truck, and berry crop divisions. This factor was considered when weighted average consumptive uses were calculated for each nodal area.

Table 15 lists agricultural crops both individually and by types, and provides a unit consumptive use figure for each entry.

In 1958, crop consumptive use data were converted to total water requirements for each nodal area of the ground water model network. This was accomplished by multiplying each crop's net acreage (as recorded in the Department's 1958 land use survey) by the appropriate consumptive use figure. The sum of the individual crop requirements is the total agricultural consumptive use for each nodal area.

TABLE 15

AGRICULTURAL UNIT CONSUMPTIVE USE
(in acre-feet per acre)

<u>Subtropical Fruits</u>	2.52
Grapefruit	
Lemons	
Oranges	
Dates	
Avocados	
Olives	
Miscellaneous	
<u>Deciduous Fruits and Nuts</u>	3.50
Apples	
Apricots	
Cherries	
Peaches and nectarines	
Pears	
Plums	
Prunes	
Figs	
Miscellaneous or mixed	
Almonds	
Walnuts	
<u>Grain and Hay Crops</u>	1.12
Barley	
Wheat	
Oats	
Miscellaneous and mixed	
<u>Forage Crops</u>	3.90
Alfalfa	
Clover	
Mixed	
<u>Vineyard</u>	2.10

<u>Rice</u>	4.55
<u>Field Crops</u>	
Cotton	2.53
Safflower	2.93
Flax	--
Hops	--
Sugar beets	2.67
Corn	2.26
Grain sorghum (milo)	2.13
Sudan	--
Castor beans	2.90
Beans (dry)	1.83
Miscellaneous	2.60
<u>Truck and Berry Crops</u>	
Artichokes	--
Asparagus	--
Beans (green)	--
Carrots	2.10
Celery	--
Lettuce	--
Melons	2.10
Onions and garlic	1.93
Peas	--
Potatoes	1.77
Sweet potatoes	--
Spinach	--
Tomatoes	2.10
Flowers and nursery	--
Miscellaneous truck	2.00
Bushberries	--
Strawberries	--
Peppers	--

-- Crops not grown in study area or data not available.

In each node, the total consumptive use requirement was divided by the gross 1958 irrigated acreage to develop nodal consumptive use factors applicable to gross irrigated acreage during the modeling process.

Consumptive use requirements for 1966 were developed by applying the consumptive uses of 1958 to acreage identified by the Department's 1966 irrigated land survey.

In 1969, a detailed land use survey of the model area was completed by the Department. Through use of a computer, data were converted into a nodal breakdown of individual crops and total irrigated acreage within each node. New nodal unit consumptive use factors were calculated from this information, and the results were compared with those established in 1966. Adjustments were made in the use factors where discrepancies were obvious.

Finally, the revised factors were made part of the data base used for the digital computer simulation modeling. As changes occur in the total irrigated land, the computer calculates new consumptive use requirements for the entire model.

Recreational Consumptive Use

Studies revealed that a unit factor of 0.9 m^3/m^2 (3 acre-feet per acre) represents the water (used to grow feed or ponded to attract migratory waterfowl) lost in operation of duck hunters' clubs in the area.

Municipal and Industrial Consumptive Use

A local survey was conducted to determine the percentage of total water demand used consumptively by municipal and industrial concerns located within the study area. It was found that the average consumptive use requirements in the urban Bakersfield area changed from 63 percent of the total demand in the 1960-62 period to 62 percent of the demand in 1966.

The investigation also revealed that, for nodes associated with other communities, consumptive use factors differed slightly and were generally less than those assigned to the Bakersfield area.

Since the model's total municipal and industrial consumptive water use was defined as a percentage of the total municipal and domestic water demand, an investigation of historical water deliveries in urban areas was undertaken. It was found that water demand calculated on a per capita basis varied from node to node (as well as year to year) in the urban

Bakersfield area, but when the area was taken as a whole the per capita demand changed only slightly. This finding justified the assumption that municipal and industrial use was directly related to population.

From 1960 to 1962, the annual per capita Bakersfield demand was 520 m^3 (0.42 acre-foot), and by 1966 it rose to 530 m^3 (0.43 acre-foot). This figure is slightly higher than the Kern County average of 488 m^3 (0.396 acre-foot) set forth in the August 1968 Department of Water Resources Bulletin No. 166-1, "Municipal and Industrial Water Uses". This bulletin also estimates a per capita use factor of 490 m^3 (0.40 acre-feet) for the Fresno area. The Kern County figure is probably higher than average because of increased use of water for lawn irrigation and extensive use of evaporative coolers dependent on low-cost, unmetered water.

Municipal and industrial use projections are directly related to urban population projections. This projection through the base period (and for future use) was accomplished by correlating federal census tracts with nodal boundaries. Reported populations for the years 1960 and 1970 were then assigned to each nodal area.

Straight-line projections of these data established the population trend through the 1958-66 base period and formed the basis for future projections.

The information was modified by using Kern County Planning Commission projections for 1980, 1990, and 2000. The final yearly estimates were tabulated for computer use to determine the municipal and industrial water demands on a nodal and community basis.

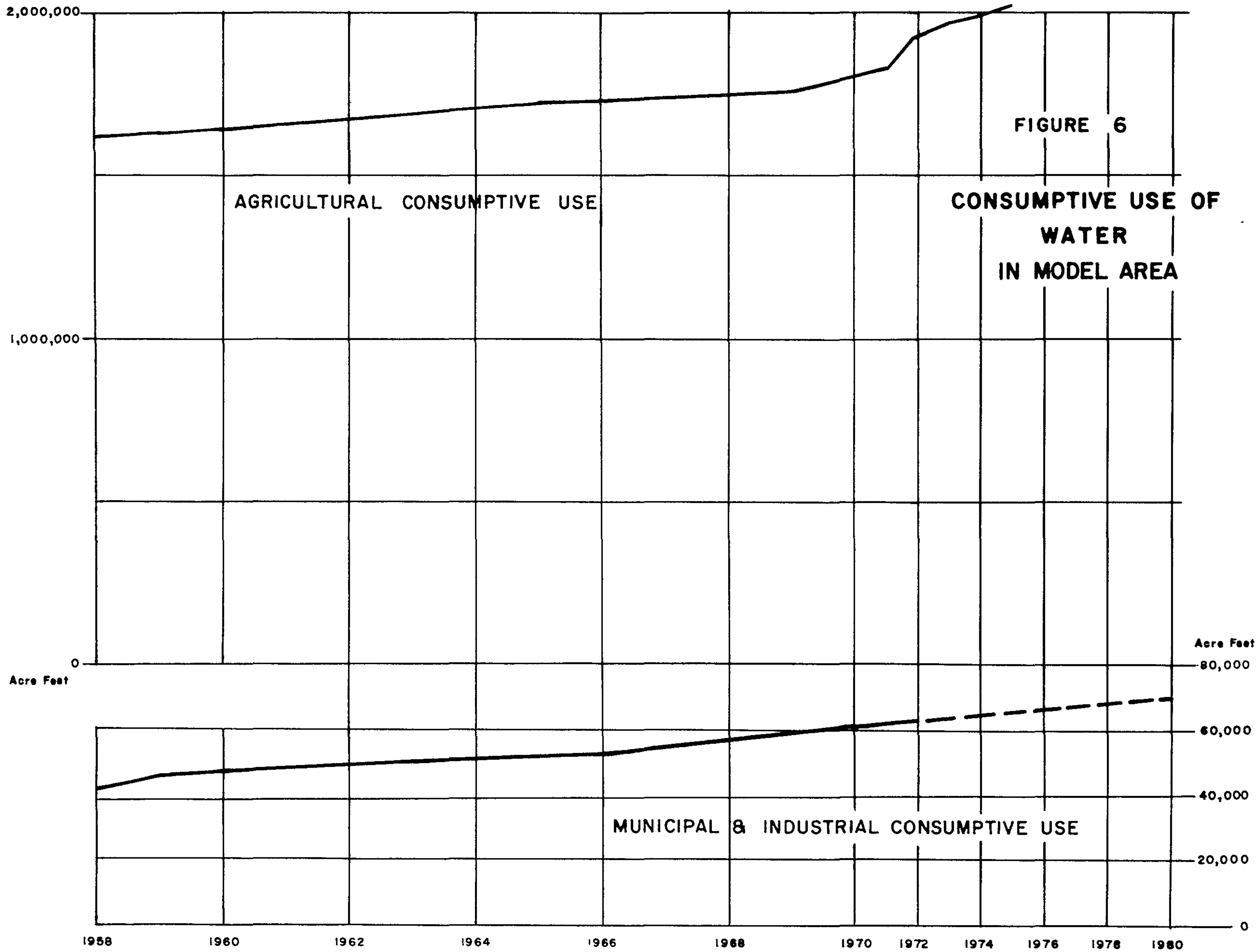
A graphic comparison of the agricultural and municipal consumptive use trends is provided on Figure 6.

Ground Water Extractions for Export

An annual average of nearly 18 hm^3 (15,000 acre-feet) of water was extracted for export from the study area's ground water basin during the nine-year base period. The exports are indicated in Table 32 (Appendix B).

Alpaugh Irrigation District

Alpaugh Irrigation District has diverted water through unlined canals and associated structures for irrigation use in Tulare County. Calculated transmission losses for the base period were considered as surface water supply in the model area. Total extractions were recorded in the net basin inflow



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section of the ground water model, but only water actually leaving the County was classified as exported ground water.

The average district extraction for the base period was 18 hm^3 (15,000 acre-feet), while losses totaled 4 900 000 m^3 (4,000 acre-feet) and the average annual export amounted to 14 hm^3 (11,000 acre-feet).

West Kern County Water District

West Kern County Water District pumps water from a well field near Tupman (Sections 21 and 28, T30S/R25E, MDB&M) and conveys it to the Taft area for municipal use and to adjacent oil fields for industrial use. Water is occasionally diverted from this system for agricultural use outside the study area, but such use represents only a small portion of the total export.

Average annual exports by West Kern County WD during the base period amounted to 3 800 000 m^3 (3,100 acre-feet). West Kern County WD plans to use its future California Aqueduct entitlement for a spreading recharge operation that will replace water exported from the basin.

Lost Hills Water Company

Lost Hills Water Company pumps ground water from wells in Section 33, T26S/R23E, MDB&M, for urban use at Lost Hills and for industrial use in nearby oil fields. (Water used in oil field operations is considered exported water.) Urban use during the base period averaged 20 000 m^3 (16 acre-feet) per year, and the annual export averaged 104 000 m^3 (84 acre-feet).

Belridge Oil Company

Belridge Oil Company pumps from a well field near Spicer City (Section 10, T28S/R23E, MDB&M) to supply water for oil field operations at the North Belridge Oil Field outside the study area. Extractions during the base period averaged 740 000 m^3 (600 acre-feet) per year.

Hydrologic Balance

The final hydrologic balance determined for the base period during model verification is presented in Table 16. During model calibration, many factors were changed so that computed ground water levels would simulate actual water levels at nodal points. If a supply item was reduced during calibration, there was a corresponding increase in another supply item or a decrease in an item of disposal.

TABLE 16

MODEL AREA HYDROLOGIC BALANCE
(in thousands of acre-feet)

Supply and Disposal	1958	1959	1960	1961	1962	1963	1964	1965	1966	Average
Supply										
Kern River	1,066	361	336	190	660	728	373	677	479	541
Minor streams	72	4	18	16	25	21	21	30	38	27
Friant-Kern Canal	237	172	187	140	238	255	201	267	239	215
Oil field waste water	5	5	5	5	5	5	6	6	7	5
Effective precipitation	236	80	105	50	147	227	92	179	68	132
Subsidence water	80	114	111	89	80	65	110	56	117	91
Net subsurface inflow	204	235	230	245	228	226	240	234	253	233
Change in storage	--	764	757	1,026	40	280	789	392	676	566
Total supply	1,900	1,735	1,749	1,761	1,790	1,807	1,832	1,841	1,877	1,810
Disposal										
Evapotranspiration										
Agriculture	1,619	1,627	1,644	1,660	1,677	1,696	1,717	1,724	1,754	1,680
Municipal and industrial	46	47	48	49	50	51	51	52	53	49
Evaporation	32	12	11	6	21	23	12	21	16	17
Loss to moisture-deficient soils	19	29	27	31	25	19	29	24	30	26
Export	12	20	19	15	17	18	23	20	24	19
Change in storage	172	--	--	--	--	--	--	--	--	19
Total disposal	1,900	1,735	1,749	1,761	1,790	1,807	1,832	1,841	1,877	1,810

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The hydrologic balance indicates an average annual overdraft of 789 hm^3 (640,000 acre-feet) during the base period. Precipitation on the valley floor approximated the 50-year mean, and Kern River runoff at First Point was about 77 percent of the 73-year mean.

CHAPTER IV. GEOLOGIC FACTORS IN GROUND WATER STORAGE AND MOVEMENT

The Kern County ground water reservoir is a structural trough bounded on three sides by mountain ranges and filled with unconsolidated sediments extending northward through the San Joaquin Valley. The limits of the area underlain by unconsolidated sediments, which contain the most important water-producing elements in the County, are shown in Plate 6. In addition, water is also obtained from semi-consolidated formations such as the Santa Margarita along the northeastern edge of the area.

The valley sediments can store and transmit much larger quantities of water than the hard, impervious rocks beneath them and in the adjacent mountain ranges. The area of usable ground water is not identical with the area of unconsolidated valley sediments, however, because some sediments either contain little or no water or contain water unfit for most domestic and agricultural purposes.

This report discusses only the most important geologic factors affecting the occurrence and movement of ground water in the valley portion of the County. These factors are confining layers, vertical geologic barriers, transmissivity, conductivity, specific yield, subsidence, and moisture-deficient soils. The geology of the ground water basin has been reported in more detail in several U. S. Geological Survey publications (Hilton, et al, 1963; Wood and Dale, 1964; Wood and Davis, 1959; and Dale, et al, 1966).

The model area was defined by factors such as limits of ground water use (as controlled by available quantity and quality), boundaries to flow (formed by faults, folds, and mountain ranges), and data availability. The sediments in the model area have variable water storage and transmission characteristics -- a result of variations in their size and distribution when they were created.

Clay Layers

In the unconsolidated sediments three confining clay layers -- identified as the A, C, and E clays -- were mapped by Croft in Kern County (1972). The E clay, which Croft correlates with the Corcoran clay defined by Davis (1959) in the northern part of the County, is important because it is an effective confining layer extending over most of the model area. In this study, it was found that the confined area was more extensive than the area of Croft's E clay.

Geologic data alone were insufficient to identify the boundaries of the E clay. In part of the model, it was necessary to define two water-bearing layers to reproduce the observed water levels. With two layers, each layer can have independent rates and directions of ground water movement (i.e., water can move southward in one layer and westward in the other). The area, modeled as two aquifers separated by a clay layer, is shown in Plate 7.

Only part of the model is a two-layer system. The Edison, White Wolf, and Forebay subbasins were modeled as a single, unconfined aquifer. The subbasins are shown in Plate 6. However, the Santa Margarita formation, which is the principal aquifer in the eastern part of the forebay along Highway 65, appears to be confined.

The A and C clays were not included in the model because data were insufficient to define their effects and because their omission simplified the model construction. Croft mapped the C clay at depths between 46 and 76 metres (150 and 250 feet) in the northwestern part of the County from Spicer City to the county line. He also mapped the A clay at a depth of 3 to 18 metres (10 to 60 feet) in a more limited area north of Spicer City and beneath the Buena Vista and Kern lakebeds. There are indications that both are effective confining layers, the A clay perhaps functioning mostly to cause a higher water table and consequent drainage problems. Ground water storage above the A and C clays is small and has probably changed only slightly during the calibration period. These layers cover less area than the E clay, and their omission caused no apparent problem in the model operation.

Vertical Geologic Barriers

Barriers that impede horizontal ground water movement are of four types:

1. Faults, such as White Wolf and Edison.
2. Folds, such as Elk Hills and Buena Vista Hills.
3. Angular unconformities, such as the one extending southward from Lost Hills.
4. Contacts with the crystalline and consolidated sedimentary rocks in adjacent mountains.

Faults

Three faults -- Springs, White Wolf, and Edison -- shown in Plate 6 are known to be barriers to horizontal ground water movement.

The Springs fault is outside the modeled area.

The White Wolf fault separates the main ground water basin from the White Wolf subbasin to the southeast. Water levels in the White Wolf subbasin have declined more rapidly than the unconfined water levels in the main ground water basin, and by 1973 the subbasin head was more than 30 metres (100 feet) lower than the unconfined water level in the main basin.

The Edison fault creates another subbasin consisting of Nodes 116 to 118 east of Bakersfield. Water levels in this subbasin are 55 to 131 metres (180 to 430 feet) higher than those in the main basin, with the maximum water level difference at the east end of the fault. The presumed location of the west end of the fault was moved, and the node shapes were changed during model calibration.

The recently described Pond-Poso Creek fault (Park, undated) was unknown to the Department during the period of model calibration (January 1971 to May 1973); but in order to match historical ground water levels, it was necessary to reduce transmissivity along the alignment of the fault from Highway 99 to the Tulare County line. The fault restricts the southwest flow of water in both aquifers.

Other possible fault barriers along the east side of the model area north of Bakersfield are suggested by two types of data -- linear topographic lows transverse to the drainage direction and steep water level gradients.

The faults, shown in Plate 3 and on the geologic maps of Hilton (1963) and Park (undated), are the Premier and Hodgeman Ranch faults. The effectiveness of the Premier fault as a barrier is suggested by water level data collected while this study was in progress. The effect of the Hodgeman Ranch fault is uncertain.

Nearly all of the water level data for the model area north of Poso Creek have been collected since 1969, after the January 1958-December 1966 data period used to calibrate the model. The data seem to indicate that there is little hydraulic continuity between water in the Santa Margarita formation and in the main ground water basin.

Folds

Folds, particularly those with steeply inclined layers, also impede horizontal movement of ground water. Elk Hills, Buena Vista Hills, Lost Hills, and Kettleman Hills -- all located along the western boundary of the model -- were all assumed to be barriers to subsurface flows in both layers of the model. Water levels adjacent to these boundaries were reproduced reasonably well in the model under this assumption. Buttonwillow and Semitropic ridges, located within the model area, also noticeably retard subsurface flow. Folds that affect ground water flow in the model are shown in Plate 3.

Angular Unconformities

An angular unconformity formed by sloping layers of older, more consolidated sediments underlies the younger, relatively flat-lying sediments at depths of a few hundred feet along the northwest boundary of the model area from Elk Hills to Lost Hills and from Lost Hills to Kettleman Hills.

It is uncertain from available data whether this buried ledge was formed by folding, faulting, or a combination of the two, but it restricts subsurface flow along a portion of the boundary.

Figure 7, an east-to-west cross-section through Township 25 south, MDB&M (on an alignment shown in Plate 6), shows the major clay-confining layer trending toward the older sloping sediments on the west. A similar situation exists in Township 27 south, MDB&M. Both the clay and the sediments below the unconformity have low hydraulic conductivities in this area, and where there is little or no gap between them, subsurface flow across the western boundary into the model's lower aquifer is restricted.

In contrast, Figure 8 shows in the east-to-west cross-section through Township 29 south, MDB&M (along an alignment shown in Plate 6), a much wider gap between the trend of the main confining clay layers and the barrier formed by the older sediments. As a result, the subsurface flow is larger in that area.

Similar data were obtained for the Township 28 south cross-section, showing that in both these townships the western boundary is more open to subsurface flow than farther north.

Rocks

Crystalline rocks, older inclined sandstone and shale strata, and faults of the San Emigdio and Tehachapi mountains form a barrier that defines the limit of the ground water basin along most of the southern and southwestern boundaries of the model area.

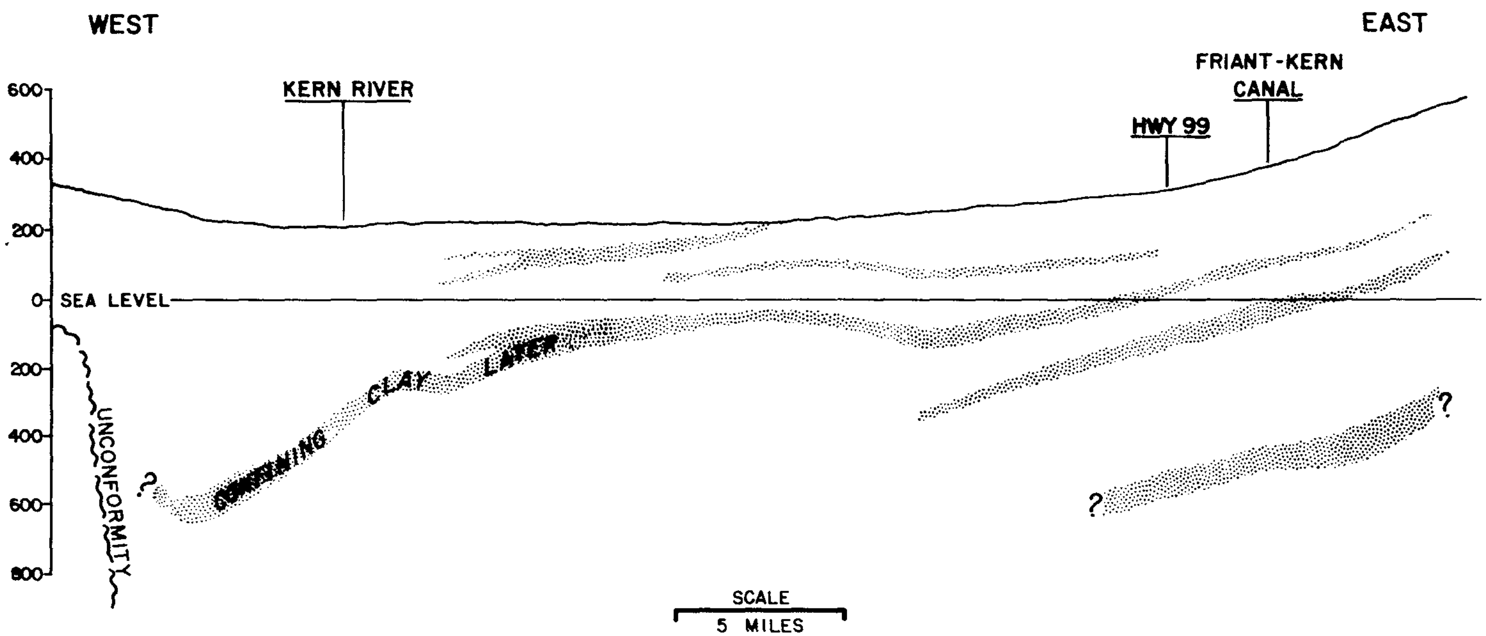

FIGURE 7 - CROSS SECTION - TOWNSHIP 25 SOUTH

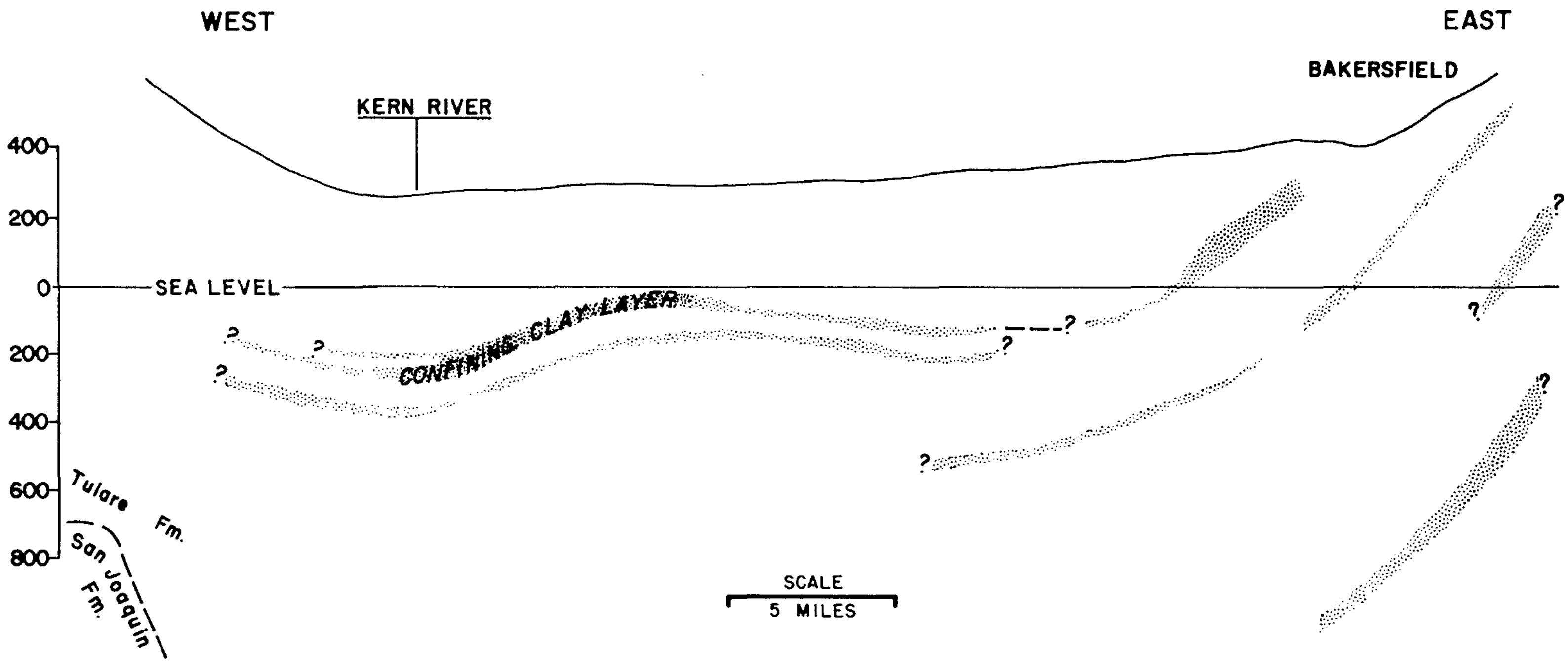

FIGURE 8 - CROSS SECTION — TOWNSHIP 29 SOUTH

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Transmissivity

Transmissivity is defined as the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Transmissivities were estimated from a few aquifer tests (McClelland, 1964) and from average specific yields.

The thickness of the upper layer above the E clay ranges from 60 to 270 metres (200 to 910 feet), with more than 90 percent of the area between 120 to 180 metres (400 and 600 feet) thick.

Because there is no clay layer to define the thickness of the water-conducting sediments in the lower and single aquifers, the fresh water base is used as a lower limit. The fresh water base may be partly controlled by physical boundaries such as layering and by a dynamic, hydraulically maintained interface. The fresh water base was defined by electric log inspection. The estimated cutoff point is water with a specific conductance of less than 3 000 micromhos per centimetre, which represents about 2 000 mg/l total dissolved solids. The method, which is of limited accuracy, is described in Page (1973). The reference also contains a map showing the base of fresh water.

This assumption resulted in high estimates of transmissivity, and it now appears that the depth of deep wells would have been a better guide to the present ground water circulation pattern. It also seems that the transmissivity of the older sediments was overestimated.

Conductivity

For the purposes of this report, conductivity is defined as the transmissivity multiplied by the width of the flow path and divided by the length of the flow path between nodes. Conductivity is the combination of all the constant values required to describe the internodal flow path to the computer. When multiplied by the hydraulic head difference between nodes -- the variable computed by the model -- the conductivity yields the subsurface flow rate in acre-feet per year from node to node.

Many initial conductivity estimates were changed repeatedly during the calibration of the model. The changes were smaller in the upper layer, where the E clay more accurately defined the thickness of the aquifer. Conductivity values used in Operational Run A are shown in Tables 35, 36, and 37 (Appendix C).

Interlayer Conductivities

Another set of conductivities was needed to simulate flow between the upper and lower water-bearing layers. Vertical conductivity differs from horizontal conductivity in that the distances between nodes is the thickness of the confining clay. Vertical flow occurs through gravel packs around well casings that penetrate the clay layer, through composite wells that are perforated in both water-bearing layers, and through the clay layer itself. In most areas where ground water was developed, flow through the composite wells contributed the largest component of interlayer flows. A rough estimate was made of the flow through clay, gravel packs, and wells perforated in both aquifers, and the total of these flow components was used to derive initial vertical conductivity estimates.

Ground Water Mounds

The ability of the model to reproduce subsurface flow rates and water levels along the ground water mounds below the Kern River and Poso Creek is not completely satisfactory. No amount of change in conductivity or other model parameters can remedy this problem without a change in the shape of the nodes. A modification recommended by Dr. David Kleinecke is shown in Plate 8. The new flow paths would be more in line with the direction of gradient and highest conductivity.

Specific Yield

Specific yield is defined as the percentage of soil volume that will store and yield water by gravity. Information forming the basis for assigning specific yield values was taken from Table A, Attachment No. 2, Department of Water Resources Bulletin No. 104, "Planned Utilization of the Ground Water Basins of the Coastal Plain of Los Angeles County", Appendix A, "Ground Water Geology", June 1961.

Specific yield values for sand and silt given in Bulletin No. 104 are higher than those used previously and are supported by recent work (Johnson, 1967) that suggests older values are too low.

The average specific yield for each nodal area was determined by estimating the proportions of gravel, sand, silt, and clay from selected drillers logs. The highest specific yields -- 26 percent -- were assigned to sand and gravel. Clay had the lowest yield (about 3 percent). Values for other materials are indicated in Bulletin No. 104 (reproduced in Table 39, Appendix C).

Initial average specific yield for the nodes ranged from 5.0 to 16.1 percent, and during model calibration the values were adjusted to final figures ranging from 8.0 to 19.5 percent. The ratio of final value to initial value ranged from 0.75 to 2.00 and averaged 1.28. The final values used in Operational Run A are given in Table 35 (Appendix C).

To maintain an appropriate hydrologic balance in the model, increased storage yield (caused by increases in specific yields) was offset by both reduced subsurface inflow and increased consumptive use by crops. The distribution of final specific yield values by 2-percent increments is shown in Plate 9.

When the specific yield is multiplied by the area in acres, the result is acre-feet of storage per foot of change in elevation of the water table in the sediments. Storage amounts for the unconfined nodes (shown on Plate 7) were added to obtain the per foot storage capacity of the unconfined aquifer for each subarea (shown in Table 17).

TABLE 17

STORAGE CAPACITY
UNCONFINED NODAL AREAS

Subarea	Storage per Foot of Depth in Unconfined Aquifers (acre-feet)
Edison	2,000
White Wolf	6,500
Forebay	22,300
Upper Aquifer	127,000
Total (rounded)	158,000

In the unconfined aquifer, a reduction in water level in a well represents a change in the saturated material level and results in a consequent drainage of water from the pores of the material.

A different hydrologic situation is presented by the confined aquifer where, if water pressure remains above the base of the confining layer, a measured water level change in a well tapping the confined aquifer represents a change in pressure in the aquifer.

The confined aquifer is compressible, as is, to a small degree, the water it contains. When water is removed, pressure is reduced and the system compresses elastically.

The volume of water an aquifer releases through this mechanism per unit surface area of the aquifer per unit change in head is defined as the storage coefficient, a dimensionless number.

For the confined aquifer, then, the storage coefficient is related to the ability of the aquifer system to deform elastically. As measured by a water level difference in a well tapping only that aquifer, the coefficient is very small compared to that of the unconfined aquifer and, in the model, ranged from 0.03 to 0.12 percent per unit of head change. Values used in Operational Run A are shown in Table 34 (Appendix C). (The same elastic effect operates in the unconfined aquifer; but compared to the result of dewatering, the storage contribution from deformation is considered negligible.)

As a result of the confined aquifer's low storage coefficient, the storage change per foot of water level change in the entire lower aquifer (which has the same area as the upper aquifer) is just 567 000 m^3 (460 acre-feet), or approximately .33 percent of the upper aquifer's capacity.

By comparing storage change in the two types of aquifers, the above analysis ignores subsidence. Subsidence promotes a different type of yield in that the void space occupied by the water is permanently reduced by inelastic deformation. As a result, storage space is permanently lost. Most of this permanent storage change, however, probably occurs in the fine-grained sediments of the confined aquifer and does not affect the coarser sands essential to ground water movement and to well yields. The storage change due to subsidence is discussed in the following section.

Due to the great differences between the confined and unconfined aquifers' storage coefficients, it is vital to know whether a well's water level represents a water table, a confined aquifer pressure surface, or some combination of the two. Calculations of storage changes from unknown or improperly classified water levels can result in incorrect ground water storage values. Contours drawn on the basis of this information can be misleading as to the direction of ground water movement and cannot be used as a measure of subsidence stress.

Subsidence

Most subsidence occurs in the aquifer's confined lower layer since a pressure change there promotes compressive stress that is greater than in the unconfined zone. Released from storage by subsidence, water in fine-grained sediments contributed more than 1 430 hm^3 (1,160,000 acre-feet) to the Kern County supply during the 15-year period between January 1958 and January 1972. The mechanics of subsidence are discussed in detail by Lofgren (1969), and the average subsidence for each nodal area between 1958 and 1972 is shown in Tables 33 and 34 (Appendix C). Contours of equal subsidence are presented in Plate 10.

Subsidence can be measured by placing an anchor in a bore hole and gaging compaction of sediments between the ground surface and the anchor. Two or more bore holes, with anchors at different depths, are used to determine which depth intervals are experiencing subsidence. In the two-layer area, nearly all subsidence occurs in the lower layer.

Another method of measuring subsidence is by determining the elevation changes in a network of benchmarks over a period of years. Contours of elevation changes are then drawn, and the area's subsidence volume is computed for each time period.

Benchmarks are located at all bore hole compaction recorders so that total subsidence can be compared to measured compaction to determine if subsidence is occurring below the interval measured by the deepest recorder.

In deep aquifers below the water table, subsidence reduces the pore space in silts and clays -- squeezing out water contained in the pores. This change in storage occurs in addition to ground water level fluctuations. Since the reduction in pore space equals the amount of water forced out, the amount of water obtained is assumed to equal the volume of subsidence measured by resurveying the surface benchmarks.

Subsidence data are collected by the U. S. Geological Survey in cooperation with the Department. The two subsidence areas of concern are the Tulare-Wasco area, affecting the north part of the model, and the Arvin-Maricopa area, affecting the south part of the model. Subsidence in the Tulare-Wasco area (through 1962) is described by Lofgren and Klausing (1969). Lofgren (1975) provides similar information on the Arvin-Maricopa area through 1970. Poland, et al (1975), reviews all San Joaquin Valley subsidence and extends the Tulare-Wasco area information through 1972.

Subsidence volumes were determined from changes in benchmark elevations measured in a 1965 survey of the Arvin-Maricopa area and from information collected in surveys of both areas in 1957, 1959, 1962, and 1970. Surveying is always done in the winter (assumed to be January of the above years) when subsidence has ceased or is taking place at a minimal rate.

The volumes of subsidence water, measured for two- to eight-year periods, were divided into annual amounts for use in the model. The basis for the annual portions were the continuous compaction records and monthly water level measurements. For the Arvin-Maricopa area, two recorders with continuous records from 1963 were employed -- one in Section 20, T32S/R28E, MDB & M, measuring the 0-to-300-metre (970-foot) depth interval; the other located in Section 3, T11N/R21W, SBB & M, measuring the 0-to-450-metre (1,480-foot) depth interval.

Since 1959, the Tulare-Wasco area data have been kept by one recorder located in Section 34, T24S/R26E, MDB & M, measuring the 0-to-670-metre (2,200-foot) interval, and two recorders in Section 16, T23S/R25E, MDB & M, measuring the 0-to-230-metre (760-foot) and the 0-to-130-metre (430-foot) intervals. The two recorders at the latter site (near Pixley) are the Valley's most accurate, and their graphic records (published as Figure 70 in Poland, et al, 1975) are reproduced here in Figure 9. The figure also shows the subsidence at Benchmark Q945 at the recorder site in Section 16.

The figure illustrates the seasonal variation in compaction rates and reflects the difference in annual compaction between wet and dry years. In several wet years, the annual subsidence is approximately 0.03 metre (0.1 foot), but in several dry years it is about 0.15 metre (0.5 foot). The annual compaction rates (from Table 6 of the same reference) are reproduced in Table 18.

After 11 model calibration runs, the initial annual subsidence distribution was adjusted to improve agreement between measured and computed ground water elevations. Nearly all adjustments prompted a shift of subsidence water yield from dry to wet years. The annual distribution of subsidence water used in Run 12 and succeeding runs is shown in Table 19.

Extraction rates in the lower aquifer must be balanced by subsurface inflow rates and rates of change in storage -- including subsidence. In the first nine years of the calibration period for which data were tabulated, most of the water pumped from the lower layer came from subsurface flow from the overlying nodes (56 percent) and the forebay (19 percent). Although subsidence accounted for 20 times more water than elastic storage, it represented just 12 percent of the total water pumped from confined nodes.

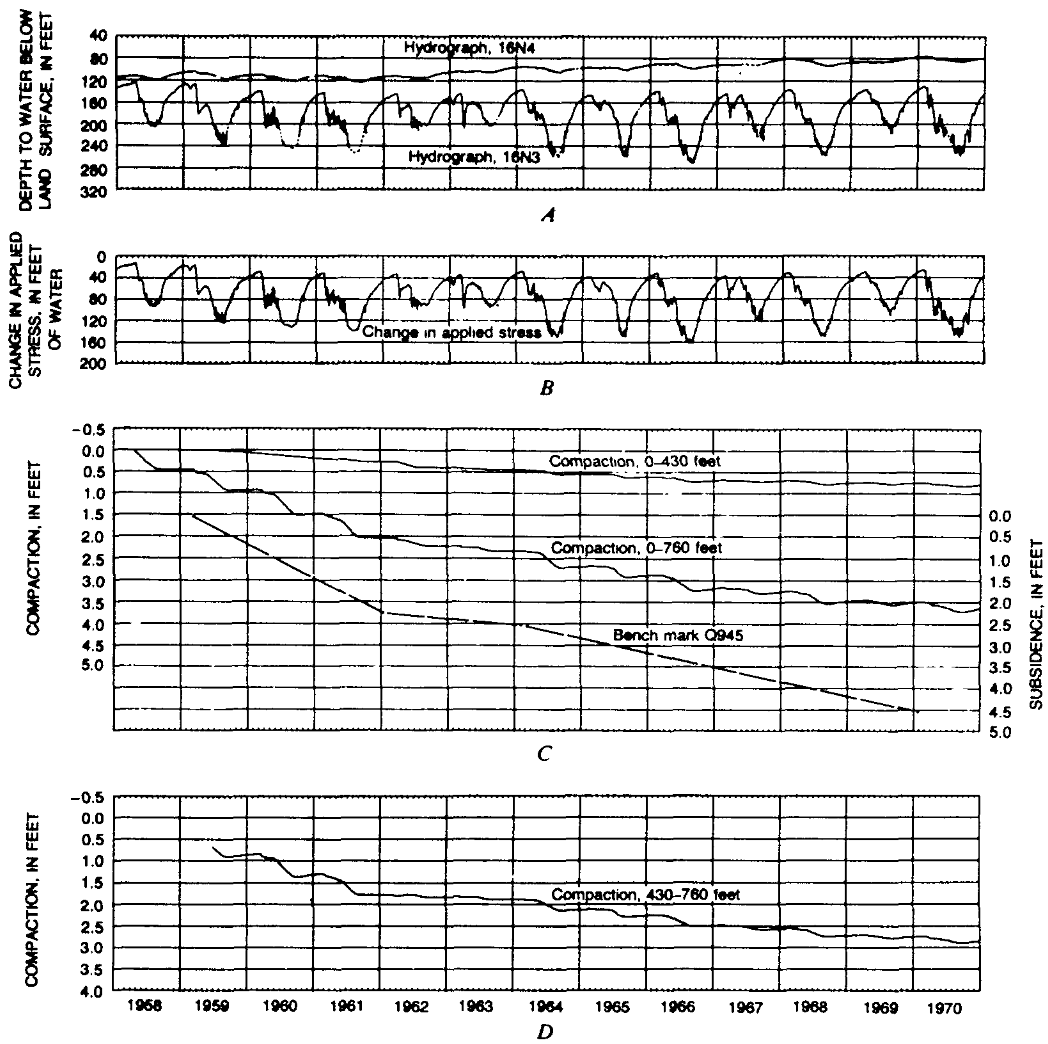

FIGURE 9 - WATER LEVEL AND COMPACTION RECORDS FROM RECORDERS NEAR PIXLEY (T23S - R25E SEC. 16 N. M.D.B.& M.)

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TABLE 18

ANNUAL COMPACTION RATES AT COMPACTION-MEASURING SITES
SAN JOAQUIN VALLEY, CALIFORNIA

Well Number	Anchor Depth When Installed (feet)	Depth Interval (feet)	Start of Record 1/	Year													Total Measured Compaction (feet)
				1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	
Arvin-Maricopa Area																	
32S/28E-20Q1	970	0- 970	4/11/63	--	--	--	--	--	0.192	0.365	0.178	0.255	0.219	0.124	0.124	0.095	1.552
12N/21W-34Q1	810	0- 810	6/02/60	--	--	0.207	0.326	0.271	.209	.186	.266	.197	.130	.014	.186	.153	2.145
11N/21W-03B1	--	810-1,480	4/12/63	--	--	--	--	--	.188	.261	.135	.229	.184	.344	.152	.149	1.642
11N/21W-03B1	1,480	0-1,480	4/12/63	--	--	--	--	--	.326	.447	.401	.426	.314	.358	.338	.302	2.912
Tulare-Wasco Area																	
23S/25E-16N4	250	0- 250	6/24/59	--	0.005	.024	.024	.008	.007	.022	.009	.001	0	.003	-.002	0	.101
23S/25E-16N3	430	250- 430	6/24/59	--	.055	.100	.062	.120	.042	.080	.048	.085	.003	.057	.005	.033	.690
23S/25E-16N1	760	430- 760	6/24/59	--	.184	.433	.473	.051	.056	.253	.131	.225	.063	.160	.036	.100	2.165
23S/25E-16N1	760	0- 760	4/18/58	0.454	.482	.557	.559	.179	.105	.355	.188	.311	.066	.220	.039	.133	3.648
24S/26E-34F1	1,510	0-1,510	1/21/59	--	.242	.100	.111	-.051	.018	.063	-.025	.068	-.031	.038	-.057	.038	.514
24S/26E-36A2	2,200	0-2,200	5/12/59	--	.059	.342	.333	.059	.096	.329	.062	.145	-.045	.168	-.060	.143	1.631
25S/26E-01A2	892	0- 892	4/06/59	--	.058	.061	.059	-.013	-.004	.050	-.003	.096	-.012	.018	-.001	.014	.323

1/ Date when stabilized installation began giving acceptable record.

Note: a minus sign (-) indicates expansion.

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TABLE 19

VOLUMES AND PROPORTIONS OF SUBSIDENCE
USED IN KERN COUNTY GROUND WATER MODEL

Year	Subsidence Area				Total (acre-feet)	Percent of Annual Average
	Tulare-Wasco		Arvin-Maricopa			
	(acre-feet)	(percent of total)	(acre-feet)	(percent of total)		
1958	39,100	49.1	40,600	50.9	79,700	103.1
1959	50,000	43.7	64,300	56.3	114,300	147.9
1960	54,900	49.5	56,100	50.5	111,000	143.6
1961	52,300	58.9	36,500	41.1	88,800	114.9
1962	34,800	43.3	45,700	56.7	80,500	104.2
1963	29,600	45.7	35,200	54.3	64,800	83.8
1964	66,700	60.5	43,600	39.5	110,400	142.8
1965	35,300	62.9	20,900	37.1	56,200	72.7
1966	51,400	44.1	65,100	55.9	116,500	150.8
1967	17,000	24.8	51,700	75.2	68,800	89.0
1968	53,300	56.1	41,700	43.9	95,000	123.0
1969	6,800	17.8	31,600	82.2	38,400	49.7
1970	25,700	54.2	21,700	45.8	47,400	61.3
1971	23,400	72.4	8,900	27.6	32,400	41.9
1972	47,500	86.1	7,700	13.9	55,100	71.3
Average	39,200	50.7	38,100	49.3	77,300	100.0
Projected Annual Amount 1973-90	9,700	63.2	5,700	36.8	15,400	19.9

C —0 4 0 7 2 0

Table 20 shows the amount of subsidence water compared with the amount determined from the elastic storage coefficient (amounts are those of the confined nodes).

TABLE 20

SUBSIDENCE AND ELASTIC STORAGE CHANGES
IN 174 CONFINED NODES
1958 - 1966

Year	Confined Nodes Subsidence (acre-feet)	Storage Change (acre-feet)	Total (acre-feet)
1958	73,300	7,700	81,000
1959	101,300	8,700	110,000
1960	98,100	4,700	102,800
1961	77,400	8,500	85,900
1962	71,100	-4,800 1/	66,300
1963	56,200	-200 1/	56,000
1964	91,600	7,300	98,900
1965	49,700	-1,000 1/	48,700
1966	100,100	4,900	105,000
Total	718,800	35,900	754,700
Average	79,900	4,000	83,900

1/ Minus sign indicates that the amount of water in storage increased.

In the 1959-61 dry period, the model area's ratio of subsidence water to total surface water supply ranged from .20 to .25.

Since the late 1960's, new supplies of imported water have reduced the impact of subsidence on the Arvin-Maricopa area, although measurements of post-1970 subsidence volumes are still needed.

In Operational Run A (May 30, 1974) -- in which it was assumed that California Aqueduct deliveries would be nearly full by 1980 and water supplies from all other sources would be average -- a steady decline of water levels in the confined aquifer and the adjacent forebay was predicted through 1990 (the limit of the projection term). This finding suggests that subsidence will persist in the Tulare-Wasco area for more than 15 years.

For the Arvin-Maricopa subsidence area, the same run predicted rising water levels in the confined layer. A small overdraft was anticipated in the northern part of the area through 1987, but small water level declines in the unconfined layer were the result. This suggests that subsidence will soon be halted in the Arvin-Maricopa area.

Since above-average amounts of subsidence will persist in dry years in the Tulare-Wasco area, benchmarks there should be surveyed and subsidence water volume should be calculated approximately every five years.

Moisture-deficient Soils

Normal soils lying between the water table and the land surface contain moisture that cannot be removed by gravity -- a characteristic known as specific retention. When water is added to these soils, it moves through the soil to the water table under the force of gravity.

Moisture-deficient soils are those with a moisture content less than that of normal specific retention. Before percolated water can replenish the ground water supply, the moisture deficiency must be satisfied -- that is, the water required to raise the moisture content to the level of specific retention must be added.

Moisture-deficient soils are found along the west and south sides of the model and extend outside the model area to the west, in a pattern shown in Plate 11.

Moisture-deficient soils are not limited to the west and south sides of the model but are known to be important hydrologically in these areas because of their thickness (up to 46 metres, or 150 feet).

Moisture-deficient soils to depths of 0.9 to 4.6 metres (3 to 15 feet) were found in seven test holes drilled on nonirrigated land in central and eastern Kern County. Soils in the White Wolf subbasin and in the low foothills along Highway 65 (north of Bakersfield) were not tested, but large deficiencies are expected to be present.

Moisture-deficient soils are important to the model operation because applied water is absorbed and stored in these soils until the deficit is satisfied. Only then does the applied water begin to replenish ground water supplies.

In the spring of 1958, the initial estimate of the model's water deficit was 2 316 hm^3 (1,878,000 acre-feet). The total Kern County deficit was estimated at 4 206 hm^3 (3,410,000 acre-feet).

The soils west of the model are the only soils outside the model area known to be moisture-deficient.

One effect of the moisture-deficient soils is that, until the west side deficit -- including the shortage outside the model -- is satisfied, percolation from newly irrigated lands in that area will contribute little to the movement of poor-quality water toward the pumping trough in the center of the Valley.

Area Moisture Deficiency Studies

The concept of moisture-deficient soils was suggested in the late 1950's from analyses of laboratory data on soil samples taken from the west side of the Tulare Lake Basin during the Department's shallow subsidence investigation (Department of Water Resources' "Progress Report", 1958). Drilling to determine the thickness and range of moisture-deficient soils was completed early in 1960 as part of the staging and programming studies for the San Joaquin Valley Drainage Investigation.

Cause of Moisture Deficiency

The original Department report does not speculate on the causes of moisture deficiency, but a hypothesis is advanced by Dr. David K. Todd, consulting engineer and professor of civil engineering at the University of California (Todd, 1962).

Dr. Todd suggests that moisture-deficient soils are caused by the same mechanism believed to produce soils susceptible to shallow subsidence (hydrocompaction).

According to this hypothesis, mud flows deposit porous, clay-rich soils that are later covered by other mud flows. Water percolating under natural conditions never wets the soil enough to weaken the clay particle bonds and collapse the voids.

For the most part, the area where mud flows were observed coincides with the shallow subsidence soils. In the model area, however, moisture-deficient soils have been discovered where mud flows never occurred.

Agricultural soil scientists have also observed subsoils 6 metres (20 feet) thick that were as dry as the moisture-deficient soils (Alway, et al, 1919; Batchelor and Reed, 1923). The cited authors attributed the dry soil to the arid climate and deep-rooted perennial plants that continue to remove soil water through the dormant season.

The plant-root hypothesis, however, calls for a long lack of percolation -- long enough in some areas for more than 46 metres (150 feet) of soil to accumulate. Such a time period might easily include the last pluvial episode, when Pliestocene lakes were last filled.

It appears that another mechanism could be responsible for the moisture-deficient soils in the model area: a transfer of moisture in the form of water vapor from the deep subsoil to the earth's surface. Vapor transfer has been studied by an agricultural soil scientist (Baver, 1948) but only in reference to its effect on seasonal moisture changes in the root zone.

Where the creation period of moisture deficiency can be measured in centuries and the depth to water is commonly more than 30 metres (100 feet), vapor pressure -- aided perhaps by changes in barometric pressure such as those behind the "blowing and sucking well" phenomena (Ferris, et al, 1962) -- may be an effective mechanism for drying the deep subsoil.

Moisture Deficiency Classification

In the Department's initial examination of moisture-deficient soils, soils with a moisture content at least 10 percent less than the specific retention were labeled deficient. The criterion is also expressed by the following formula.

$$MC = n - SY - 10$$

where: MC = moisture content (percent by volume),
n = porosity (percent by volume), and
SY = specific yield (percent by volume).

Porosity minus specific yield (n - SY) equals specific retention. Porosity and moisture content were determined by laboratory tests, and specific yields of 3, 5, 10, or 25 percent were assigned to samples on the basis of sieve tests and/or visual classifications.

More accurate methods of determining specific yields are now available (in particular, one developed from a relationship between particle size and specific yield by Johnson, 1967), but data from the original work are insufficient to allow a redetermination of the yields of the samples. As a result, specific yields used in the original study were also used in the model study to determine the amount of moisture deficiency.

The 10-percent correction factor used in the criterion for moisture deficiency appears to have been applied to distinguish clear instances of moisture deficiency from cases arising from error (mainly in the value of specific yield). The 10-percent correction was used to classify the soils but not to calculate the deficit described below. The methods used to determine specific yield and its effects on the Tulare Lake Basin study were also discussed by Dr. Todd.

The criterion of retention minus 10 percent was used to determine the depth of moisture-deficient soils at each test hole. Using judgment based on topography, geology, and hydrology, contours of equally deep moisture-deficient soils were mapped between the widely spaced test holes.

Amount of Moisture Deficiency

The amount of moisture deficiency in metres (feet) of water was calculated for each test hole from this relationship (Newmarch, 1961):

$$MD = \sum_{i=1}^{k} (n_i - SY_i - MC_i) \frac{d}{100k}$$

where: MD = moisture deficiency in metres (feet) of water,
k = number of samples per test hole (samples were taken at 3-metre (10-foot) intervals where possible),
i = index of summation,
n = porosity,
SY = specific yield,
MC = moisture content, and
d = depth in metres (feet) of moisture-deficient soil.

The calculated moisture deficiency for each test hole is the product of the individual sample's average moisture deficiency as well as the depth of the moisture-deficient soils. The resultant moisture deficiency at each test hole was plotted on a map, and again judgment was used to draw contours of equal moisture deficiency. Finally, the contour map was used to determine (in acre-feet) the initial moisture deficiency for each node.

Note that data used to arrive at these conclusions were sparse. Only 17 test holes were available to determine the amount of moisture deficit, and just 77 samples were taken from these holes.

Since the error of an estimate is inversely proportional to the size of the sample, it seems probable that moisture-deficient parameters would require modification if more data were available. It may be possible to discover large errors through examinations of water level responses to percolation from irrigation in the unconfined aquifer's moisture-deficient nodes, but the most accurate method of adjusting the deficit is by resampling newly irrigated lands

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on the west side to determine the depth of water penetration. (The results would be compared to the irrigation histories of the sites.) The depth to water, percolation rate, and moisture deficiency must be known to estimate the time it will take percolation to affect the water table and consequently the gradient across the model's boundary.

Water Loss to Moisture-deficient Soils

The annual water loss to moisture-deficient soils was calculated by striking a water balance to determine percolation below the root zone in each node. The relationship used -- with all terms expressed in acre-feet -- follows.

$$DP = A_{sw} + A_{gw} - CU$$

where: DP = deep percolation,
A_{sw} = applied surface water,
A_{gw} = applied ground water, and
CU = consumptive use.

The portion of deep percolation water absorbed by the soil was then calculated from the relationship:

$$L = DP \times R$$

where: L = irrecoverable loss to the soil,
DP = deep percolation, and
R = ratio of area underlain by moisture-deficient soil to total area of the node.

The amount of percolated water lost each year to moisture-deficient soil was calculated for each node by determining if the quantity of deep percolation was less than the remaining nodal moisture deficit. The portion of each node with a deficit was assumed to be uniformly deficient, and percolating water was uniformly applied. The annual water losses of all nodes to moisture-deficient soils are shown in Table 21.

In Operational Run A (May 30, 1974), the model projected a peak loss of 99 hm^3 (80,300 acre-feet) of water to moisture-deficient soils in 1976, followed by a decline to 31 hm^3 (25,100 acre-feet) in 1990 -- the final year of projection. According to the run, by 1973, 24 percent of the model area's deficit was satisfied, and it was predicted that by 1990, 77 percent of the deficit would be satisfied. Moisture-deficient soils west of the model area will continue to absorb water long after 1990.

TABLE 21

ANNUAL WATER LOSS TO MOISTURE-DEFICIENT SOILS
(in acre-feet)

Year	Amount	Year	Amount
1958	19,100	1966	30,400
1959	29,200	1967	21,900
1960	27,300	1968	26,500
1961	31,000	1969	31,800
1962	24,500	1970	28,700
1963	19,100	1971	45,500
1964	28,800	1972	64,900
1965	23,800		

In-transit Percolating Water

The change from native vegetation (which consumed essentially all of the precipitation) to irrigated agriculture (which results in an annual increment of ground water recharge) increases the amount of water in transit to the water table through the soil. On land developed during the modeling period, however, the total amount of in-transit water is small in comparison to the potential error in estimating the soil's moisture deficiency. Therefore, in-transit percolating water was not considered in the analysis.

Ground Water Movement

The present lack of wells and test holes constructed for ground water observation in the area west of the model prevents monitoring of gradients to determine direction of movement and inhibits estimates of the rate of movement of poor-quality ground water found there. If this potential threat to the area's ground water supply is to be evaluated and its effects anticipated, observation wells must be drilled and data gathered.

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APPENDIX A

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APPENDIX B

HYDROLOGIC DATA

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TABLE 22

SURFACE WATER INFLOW
(in acre-feet)

Calendar Year	Kern River First Point	Calendar Year	Kern River First Point	Calendar Year	Kern River First Point
1894	533,000	1930	345,000	1966	504,500
1895	1,022,000	1931	186,000	1967	1,465,800
1896	620,000	1932	737,000	1968	497,000
1897	893,000	1933	441,000	1969	2,313,800
1898	252,000	1934	227,000	1970	601,200
1899	339,000	1935	474,000	1971	442,600
1900	332,000	1936	796,400		
1901	380,000	1937	1,260,000		
1902	553,000	1938	1,359,000		
1903	546,000	1939	461,000		
1904	493,000	1940	789,100		
1905	532,000	1941	1,401,000		
1906	1,900,000	1942	772,000		
1907	1,070,000	1943	1,221,000		
1908	506,000	1944	625,600		
1909	1,840,000	1945	938,000		
1910	660,000	1946	650,700		
1911	1,010,000	1947	406,700		
1912	388,000	1948	329,500		
1913	368,000	1949	302,900		
1914	1,110,000	1950	602,800		
1915	646,000	1951	442,200		
1916	1,992,000	1952	1,501,000		
1917	823,000	1953	548,200		
1918	538,000	1954 1/	520,200		
1919	499,000	1955	367,800		
1920	601,000	1956	755,500		
1921	509,000	1957	445,900		
1922	861,000	1958	967,500		
1923	501,000	1959	353,200		
1924	188,000	1960	324,100		
1925	466,000	1961	177,100		
1926	367,000	1962	607,800		
1927	792,000	1963	676,200		
1928	313,000	1964	361,600		
1929	323,000	1965	634,300		

Base Period Mean (1958-66) 511,800

73-year Mean (1894-1966) 668,200

$$\frac{\text{Base Period Mean}}{\text{73-year Mean}} = 76.6\%$$

1/ Isabella Dam in operation.
All subsequent flows are controlled releases.

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TABLE 22 (continued)

SURFACE WATER INFLOW
(in acre-feet)

Calendar Year	Poso Creek				
	First Point	Mons Station	Highway 155	Highway 99	Wasco-Pond Highway
1936					2,200
1937					14,400
1938					9,200
1939					300
1940					5,700
1941					10,300
1942					200
1943					86,200
1944				0	780
1945		41,000		22,212	10,401
1946		18,500		2,289	0
1947		8,905		152	0
1948		9,432		0	0
1949		9,956		0	0
1950		10,509		0	0
1951		13,740		84	0
1952		70,190		43,424	18,852
1953		25,784		0	0
1954		12,938		0	0
1955		9,352		0	0
1956		21,689		5,702	3,868
1957		7,942		0	0
1958		50,858	8,120	36,242	16,217
1959		4,498	8,195	0	0
1960	6,630	6,738	8,275	0	0
1961	2,500	2,750	8,040		0
1962	8,670	9,025	7,905		0
1963	5,970	3,806	7,765		0
1964	8,600	11,210	7,775		0
1965	23,290		7,360		200
1966	18,515		7,360		1,300
1967	27,890				10,200
1968	7,820				0
1969	101,000				40,000
Average 1958-66			7,870		1,970

TABLE 22 (continued)

SURFACE WATER INFLOW
(in acre-feet)

Calendar Year	San Emigdio Creek	Caliente Creek	Tehachapi Creek	Pastoria Creek	Santiago Creek[e]	Los Lobos Creek[e]
1958	2,580[e]	8,600[e]		2,820[e]	1,395	387
1959	30[e]	90[e]		30[e]	18	5
1960	595	1,970[e]		60[e]	322	99
1961	1,130	60[e]		280[e]	612	188
1962	671	1,710		550[e]	309	112
1963	965	457	197	230[e]	459	161
1964	754	436	0	280[e]	408	126
1965	545	1,660	0	137	295	91
1966	673	911	17	218	364	112
1967	819	1,190		433		
1968	697	362	34	600		
1969	3,870	10,180	1,050	1,730		
Average 1958-66	882	1,766		512	465	142

Calendar Year	Plieto Creek[e]	Salt Creek[e]	Tecuya Creek[e]	Grapevine Creek[e]	El Paso and Tunis Creeks[e]	Tejon Creek[e]
1958	1,980	1,278	706	827	3,785	3,463
1959	26	17	8	638	46	74
1960	460	295	17	571	79	792
1961	877	561	77	616	370	50
1962	517	332	153	774	735	688
1963	747	477	91	540	445	376
1964	585	373	77	720	370	351
1965	414	270	138	810	670	669
1966	521	243	102	494	490	367
Average 1958-66	681	427	152	666	777	759

TABLE 22 (continued)

SURFACE WATER INFLOW
(in acre-feet)

Calendar Year	Caparell Creek[e]	Chanac and Comanche Creeks[e]	Little Sycamore Creek[e]	Sycamore Creek[e]	Friant-Kern Canal	California Aqueduct (to Kern County)
1958	473	344	422	783	234,230	
1959	0	74	0	0	164,628	
1960	108	786	96	179	155,591	
1961	0	0	0	0	123,979	
1962	92	684	84	156	231,720	
1963	26	0	23	42	235,209	
1964	24	0	21	40	190,642	
1965	91	664	81	151	245,518	
1966	50	364	44	83	232,243	
1967					334,729	
1968					207,249	127,384
1969					390,670	141,265
1970					363,545	204,634
1971					349,155	360,151
1972						490,781
Average 1958-66	324	96	86	159	201,529	

e = estimated.

TABLE 23

PRECIPITATION RECORDS FOR STATIONS
IN KERN COUNTY GROUND WATER BASIN
(in inches)

Year	Lost Hills	Wasco	Delano	Button-willow	Bakers-field Airport	Taft	Tule Field
1899-1900	--	4.16	--	--	--	--	--
1900-1901	--	6.27	--	--	--	--	--
1901-1902	--	4.59	--	--	--	--	--
1902-1903	--	4.31	--	--	--	--	--
1903-1904	--	4.11	--	--	--	--	--
1904-1905	--	8.37	--	--	--	--	--
1905-1906	--	9.08	--	--	--	--	--
1906-1907	--	4.84	--	--	--	--	--
1907-1908	--	6.75	--	--	--	--	--
1908-1909	--	5.79	--	--	--	--	--
1909-1910	--	4.25	--	--	--	--	--
1910-1911	--	6.21	--	--	--	--	--
1911-1912	--	4.54	--	--	--	--	--
1912-1913	NC	3.30	--	--	--	--	--
1913-1914	5.86	7.59	--	--	--	--	--
1914-1915	9.67	13.50	--	--	--	--	--
1915-1916	6.77	7.46	--	--	--	--	--
1916-1917	5.66	5.19	--	--	--	--	--
1917-1918	7.84	3.27	--	--	--	--	--
1918-1919	5.41	4.68	--	--	--	--	--
1919-1920	6.30	5.92	--	--	--	--	--
1920-1921	4.72	8.93	--	--	--	--	--
1921-1922	8.43	9.59	--	--	--	--	--
1922-1923	4.66	3.68	--	--	--	--	--
1923-1924	3.86	3.25	--	--	--	--	--
1924-1925	4.64	6.88	--	--	--	--	--
1925-1926	4.40	4.08	--	--	--	--	--
1926-1927	6.34	7.81	--	--	--	--	--
1927-1928	5.94	5.24	--	--	--	--	--
1928-1929	3.49	4.91	--	--	--	--	--
1929-1930	4.67	5.10	--	--	--	--	--
1930-1931	4.34	6.35	--	--	--	--	--
1931-1932	--	7.67	--	--	--	--	--
1932-1933	--	5.24	--	--	--	--	--
1933-1934	--	3.81	--	--	--	--	--

TABLE 23 (continued)

PRECIPITATION RECORDS FOR STATIONS
IN KERN COUNTY GROUND WATER BASIN
(in inches)

Year	Lost Hills	Wasco	Delano	Button-willow	Bakers-field Airport	Taft	Tule Field
1934-1935	--	11.34	--	--	--	--	--
1935-1936	--	5.86	--	--	--	--	--
1936-1937	--	10.24	--	--	--	--	--
1937-1938	--	11.83	--	--	10.43	--	--
1938-1939	--	6.76	--	--	6.86	--	--
1939-1940	--	6.42	--	--	7.23	--	--
1940-1941	10.90	12.06	--	9.69	11.61	9.73	--
1941-1942	7.13	7.85	--	7.28	5.04	NC	--
1942-1943	7.73	9.61	--	8.12	9.64	8.58	--
1943-1944	3.93	4.99	--	4.18	5.16	4.66	--
1944-1945	4.51	7.17	--	4.34	7.36	6.07	--
1945-1946	4.11	4.58	--	3.86	5.14	4.21	--
1946-1947	3.27	3.67	--	4.17	5.18	NC	--
1947-1948	2.95	3.63	--	3.01	4.44	3.23	--
1948-1949	4.19	4.49	--	4.29	4.06	3.53	--
1949-1950	3.62	3.86	--	3.35	4.88	3.47	4.33
1950-1951	2.31	3.60	4.47	4.37	5.21	3.36	5.32
1951-1952	7.97	8.39	9.35	7.10	8.68	NC	6.99
1952-1953	4.73	4.75	5.75	5.13	6.39	4.20	6.24
1953-1954	5.31	5.42	6.02	5.03	4.41	4.30	4.01
1954-1955	5.30	5.17	6.02	4.09	4.64	4.89	3.72
1955-1956	4.25	4.80	5.32	3.11	3.90	3.49	4.97
1956-1957	2.78	4.75	5.18	3.53	4.70	6.05	6.35
1957-1958	8.56	12.28	13.69	8.20	10.01	8.01	8.83
1958-1959	2.29	4.13	5.87	3.19	2.45	5.00	2.77
1959-1960	3.96	3.98	4.43	3.14	4.30	3.87p	3.91
1960-1961	4.44	4.65	6.22	4.34	4.07	4.12	3.63
1961-1962	7.97	9.13	8.52	8.60	6.44	9.33	5.58
1962-1963	4.89	6.60	6.41	3.86	4.55	4.72	4.53
1963-1964	3.86	4.66	5.42	2.90	4.60	4.13	5.11
1964-1965	6.05	6.01	7.47	4.97	5.75	5.80	5.53
1965-1966	5.71	3.94	4.73	4.84	5.18	6.17p	5.37
Years of record	44	67	16	26	29	23	17

-- = no record; NC = incomplete record; p = partially estimated.

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TABLE 24

COMPUTED MONTHLY AREAL PRECIPITATION FOR MODEL AREA 1/
1958-1966
(in inches)

Month	Year								
	1958	1959	1960	1961	1962	1963	1964	1965	1966
January	1.07	0.56	1.05	0.59	0.81	0.13	0.45	0.65	0.81
February	2.00	1.39	1.26	0.20	4.91	1.46	0.18	0.25	0.95
March	1.07	0.00	0.66	0.42	0.33	1.18	0.48	0.98	0.10
April	2.09	0.40	0.68	0.13	0.00	1.03	0.57	1.88	0.00
May	0.65	0.17	0.00	0.00	0.12	0.71	0.13	0.00	0.00
June	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.02
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00
August	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.00	0.00
September	0.73	0.00	0.00	0.00	0.00	0.63	0.08	0.19	0.00
October	0.00	0.00	0.20	0.00	0.15	0.87	0.67	0.00	0.00
November	0.40	0.00	2.74	0.66	0.00	1.07	0.59	1.24	0.53
December	0.00	0.39	0.00	0.62	0.00	0.22	0.85	1.56	0.98
Total	8.01	2.91	6.59	2.63	6.32	7.70	4.08	7.09	3.37

1/ Weighted by Thiessen Polygon method for the seven stations in Table 23.

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TABLE 25

EFFECTIVE PRECIPITATION USED BY CROPS IN MODEL AREA
1958-1966
(in thousands of acre-feet)

Crop	Year								
	1958	1959	1960	1961	1962	1963	1964	1965	1966
Alfalfa	79.0	32.2	54.6	30.0	54.3	72.4	42.7	74.5	29.6
Pasture	12.4	4.6	5.1	2.6	4.8	10.7	4.9	8.2	3.1
Potatoes	25.9	7.1	11.4	3.3	16.3	18.4	4.6	14.9	4.2
Barley	49.1	20.9	25.9	7.6	41.8	32.3	11.5	23.5	12.0
Onions	1.0	0.5	0.6	0.5	1.5	0.6	4.0	8.4	0.5
Beets	2.3	0.4	0.7	0.3	1.5	7.1	2.6	5.5	1.9
Cotton	19.9	3.6	--	--	1.6	24.3	4.4	7.1	--
Vineyard	13.6	5.8	6.7	2.0	15.2	12.8	4.3	9.8	5.3
Deciduous orchard	0.7	0.1	0.2	0.1	0.1	1.6	0.7	1.2	--
Subtropical	0.4	0.2	0.3	0.1	0.8	0.5	0.2	0.3	0.5
Miscellaneous field	27.8	0.3	6.4	2.5	2.1	22.3	6.0	18.1	1.0
Total	232.1	78.7	111.9	49.0	140.0	203.0	85.9	171.5	58.1

TABLE 26

MUNICIPAL POPULATION AND WASTE WATER INPUT TO TREATMENT PLANTS
1958 - 1966

Year	Delano	McFarland	Wasco	Shafter	Bakersfield	Buttonwillow	Weedpatch-Lamont	Arvin	Total
					Population				
1958	14,550	3,820	8,379	8,086	137,635	2,911	7,848	5,919	189,148
1959	14,736	3,865	8,422	8,086	140,559	2,863	7,936	5,895	192,362
1960	14,922	3,910	8,465	8,086	144,266	2,815	8,024	5,872	196,360
1961	15,108	3,955	8,513	8,000	146,743	2,767	8,112	5,848	199,046
1962	15,294	4,000	8,561	8,000	149,773	2,719	8,200	5,825	202,372
1963	15,480	4,045	8,609	8,000	152,802	2,671	8,288	5,802	205,697
1964	15,666	4,090	8,657	8,000	155,832	2,624	8,378	5,778	209,025
1965	15,852	4,135	8,705	8,000	158,861	2,576	8,466	5,755	212,350
1966	16,038	4,180	8,753	7,914	161,888	2,526	8,554	5,731	215,584
					Sewage (in acre-feet)				
1958	1,582	495	1,120	1,000	14,359	0	785	474	19,815
1959	1,624	501	1,120	1,000	14,671	0	794	472	20,182
1960	1,660	506	1,110	953	15,615	0	802	470	21,116
1961	1,722	512	1,120	1,000	14,721	0	811	466	20,352
1962	1,764	518	1,120	1,000	15,382	0	820	466	21,070
1963	1,806	530	1,120	1,000	6,092	0	838	462	21,848
1964	1,826	530	1,120	1,000	16,491	0	838	462	22,267
1965	1,875	535	1,120	1,000	16,421	0	855	458	22,264
1966	1,921	541	1,120	1,000	18,128	0	855	458	24,023

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TABLE 27

OIL FIELD WASTE WATER SUPPLY, CONVEYANCE LOSS, AND DEEP PERCOLATION
(in acre-feet)

Node No.	Year 1958	1959	1960	1961	1962	1963	1964	1965	1966
15	34	34	34	34	34	34	34	34	34
30	36	36	36	36	36	36	36	36	36
67	63	68	71	77	94	100	123	136	165
89	70	77	79	86	105	112	138	152	184
91	503	522	524	545	615	644	668	777	808
92	16	18	18	20	25	26	32	36	43
109	15	12	15	22	20	21	19	17	15
110	11	9	11	16	15	16	14	13	11
111	6	7	9	12	16	23	25	22	22
112	3	3	3	3	3	3	3	3	3
113	5	5	5	5	5	5	5	5	5
114	179	243	239	234	228	248	264	280	330
115	164	199	194	185	185	201	220	223	268
117	54	50	49	48	47	44	40	37	35
118	82	75	74	72	71	65	60	55	53
122	30	29	30	32	30	32	33	34	34
123	6	6	6	7	6	7	7	7	7
125	11	9	11	16	15	16	14	13	11
137	25	25	25	25	25	25	25	25	25
141	42	42	42	42	42	42	42	42	42
142	20	19	18	22	22	22	25	22	23
143	191	175	174	172	169	157	147	135	131
144	518	474	467	456	449	414	377	350	337
145	340	312	307	300	295	272	248	230	221
148	16	15	16	18	18	17	20	17	18
149	229	211	209	211	207	194	187	170	167
150	8	8	8	9	9	9	10	9	9
167	22	21	22	25	24	24	28	24	25
169	62	58	61	70	69	67	79	68	70
170	8	8	8	9	9	9	10	9	9
212	31	34	36	32	31	30	27	26	27
213	16	17	15	21	27	30	30	30	31
Total	2,816	2,821	2,816	2,862	2,946	2,945	2,990	3,037	3,199

TABLE 28

OIL FIELD WASTE WATER SUPPLY RECHARGE FOR AGRICULTURE
(in acre-feet)

Year	Node 88	Node 92	Node 93	Total
1958	690	805	805	2,300
1959	690	805	805	2,300
1960	690	805	805	2,300
1961	700	817	817	2,334
1962	684	798	798	2,280
1963	742	866	866	2,474
1964	789	920	920	2,629
1965	839	979	979	2,797
1966	990	1,155	1,155	3,300
Average 1958-66	757	883	883	2,524
Reported 1972 Total				4,703

TABLE 29

POPULATION DISTRIBUTION, URBAN BAKERSFIELD AREA
CENSUS TRACTS TO NODAL AREAS

Node No.	Census Tracts	1960 Population	1970 Population	Change per Year (percent)
91	1/2-1.01	1,743	2,033	1.66
112	1/2-5	1,112	1,937	7.42
113	1/2-1.01, 3/4-2, 3/4-3, 4, 1/5-5	10,405	13,560	3.03
114	51.02, 1.02, 1/4-2, 1/4-3, 1/4-6	6,424	7,972	2.41
115	4/5-9.01, 9.02, 9.03	3,099	10,054	22.44
120	1/5-9.01, 9.04, 9.05, 9.06, 9.07, 11.01, 11.02, 11.03, 23.01, 1/8-10	23,710	28,548	2.00
121	12, 13, 14, 15, 2/3-16, 20, 21, 22, 23.02	38,000	34,467	-1.00
122	1/3-16, 17, 2/3-18, 19.01, 19.02, 1/5-5	16,102	18,065	1.22
123	1/8-5, 1/8-38, 1/3-18	1,698	2,847	6.76
139	9/10-28.01, 1/4-31.01	487	2,065	32.40
140	27, 1/10-28.01, 28.02, 28.03, 28.04, 29.01, 1/4-31.01	13,501	21,225	5.72
141	1/5-24, 25, 26, 30, 1/2-31.02, 1/2-31.03	17,312	19,029	1.00
142	7/16-24	1,197	1,035	-1.35
150	3/16-24, 5/32-62, 1/6-64	2,614	2,462	-0.58
151	2/3-31.02, 1/2-31.03, 32.02, 1/16-24, 1/40-62	4,918	7,637	5.53
152	1/4-31.01, 1/2-32.01	1,908	2,088	0.94
Total		144,230	175,024	2.13

TABLE 30

MUNICIPAL POPULATION PROJECTIONS

Node No.	Municipality	Year															
		1958	1959	1960c	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970c	1980e	1990e	2000e
91	Bakersfield	1,685	1,714	1,743	1,772	1,801	1,830	1,859	1,888	1,917	1,946	1,975	2,004	2,033	2,379	2,760	3,202
112	Bakersfield	947	1,017	1,112	1,194	1,277	1,359	1,442	1,524	1,607	1,689	1,771	1,853	1,937	3,370	5,863	10,202
113	Bakersfield	9,775	10,090	10,405	10,720	11,038	11,350	11,665	11,980	12,295	12,610	12,925	13,240	13,560	14,007	14,750	14,750
114	Bakersfield	6,114	6,269	6,424	6,579	6,734	6,889	7,044	7,199	7,354	7,509	7,664	7,819	7,972	8,000	8,000	8,000
115	Bakersfield	1,709	2,404	3,099	3,794	4,489	5,184	5,879	6,574	7,269	7,964	8,659	9,354	10,054	12,265	14,963	18,255
120	Bakersfield	22,742	23,226	23,710	24,194	24,678	25,162	25,646	26,130	26,614	27,098	27,582	28,066	28,548	32,259	35,000	36,000
121	Bakersfield	38,750	38,393	38,000	37,679	37,322	36,965	36,608	36,251	35,894	35,537	35,183	34,829	34,467	34,000	34,000	34,000
122	Bakersfield	15,710	15,906	16,102	16,298	16,494	16,690	16,886	17,082	17,278	17,474	17,670	17,866	18,065	22,065	26,085	30,065
123	Bakersfield	1,468	1,567	1,698	1,812	1,927	2,042	2,157	2,272	2,387	2,502	2,617	2,732	2,847	4,754	7,939	13,258
139	Bakersfield	171	226	487	644	802	960	1,118	1,276	1,433	1,590	1,747	1,904	2,065	3,449	5,760	9,619
140	Bakersfield	11,503	12,228	13,501	13,678	14,403	15,128	15,853	16,578	17,303	18,907	19,680	20,452	21,225	23,347	25,681	28,250
141	Bakersfield	16,968	17,140	17,312	17,484	17,656	17,828	18,000	18,172	18,344	18,516	18,688	18,860	19,029	20,932	23,025	25,327
142	Bakersfield	1,229	1,213	1,197	1,180	1,164	1,148	1,132	1,116	1,099	1,082	1,065	1,048	1,035	1,082	1,131	1,182
150	Bakersfield	2,645	2,630	2,614	2,598	2,583	2,568	2,553	2,538	2,522	2,506	2,490	2,474	2,462	2,573	2,689	2,810
151	Bakersfield	4,374	4,646	4,918	5,190	5,462	5,734	6,006	6,278	6,550	6,822	7,094	7,366	7,637	11,685	17,878	27,353
152	Bakersfield	1,872	1,890	1,908	1,927	1,946	1,965	1,984	2,003	2,022	2,041	2,060	2,079	2,088	3,195	4,888	7,478
12	Delano	14,550	14,736	14,922	15,108	15,294	15,480	15,666	15,852	16,038	16,224	16,410	16,596	16,783	18,881	21,241	23,896
39	McFarland	2,864	2,898	2,932	2,966	3,000	3,034	3,068	3,102	3,136	3,170	3,204	3,238	3,269	3,645	4,064	4,531
40	McFarland	956	967	978	989	1,000	1,011	1,022	1,033	1,044	1,055	1,066	1,077	1,090	1,215	1,355	1,511
61	Wasco	7,532	7,575	7,618	7,661	7,704	7,747	7,790	7,833	7,876	7,919	7,962	8,005	8,049	8,508	8,993	9,506
62	Wasco	847	847	847	852	857	862	867	872	877	882	887	892	894	945	999	1,056
85	Shafter	4,043	4,043	4,043	4,000	4,000	4,000	4,000	4,000	3,957	3,957	3,950	3,941	3,932	4,000	4,000	4,000
86	Shafter	4,043	4,043	4,043	4,000	4,000	4,000	4,000	4,000	3,957	3,957	3,950	3,941	3,932	4,000	4,000	4,000
105	Buttonwillow	2,911	2,863	2,815	2,767	2,719	2,671	2,624	2,576	2,526	2,476	2,426	2,376	2,335	2,350	2,350	2,350
166	Weedpatch-Lamont	3,924	3,968	4,012	4,056	4,100	4,144	4,189	4,233	4,277	4,321	4,365	4,409	4,456	4,946	5,490	6,094
167	Weedpatch-Lamont	3,924	3,968	4,012	4,056	4,100	4,144	4,189	4,233	4,277	4,321	4,365	4,409	4,456	4,946	5,490	6,094
169	Arvin	5,919	5,895	5,872	5,848	5,825	5,802	5,778	5,755	5,731	5,720	5,698	5,676	5,654	5,700	5,700	5,700
Totals		189,175	192,362	196,324	199,046	202,375	205,697	209,025	212,350	215,584	219,795	223,153	226,506	229,874	258,498	294,094	338,489

c = year of census; e = estimated.

TABLE 31

CROPPING PATTERNS OF IRRIGATED LAND
1958 - 2020
(in thousands of acres)

Crop	Year			
	1958	1969	1990	2020
Grain	87.6	95.9	140	120
Cotton	193.1	231.0	250	280
Sugar beets	7.7	27.1	40	65
Miscellaneous field	53.0	64.0	124	167
Alfalfa	130.1	136.9 1/	191	195
Pasture	14.2	--	13	13
Truck	65.5	78.2	134	145
Deciduous	5.4	22.9	38	50
Subtropical	1.6	20.1	35	45
Vineyard	28.3	38.2	55	65
Total crop area (net)	586.5	714.3	1,020	1,145
Double crop		7.9	70	85
Total land in crop		706.4	950	1,060

1/ Includes pasture.

Source: basic data for Department of Water Resources
Bulletin No. 160-70.

TABLE 32

GROUND WATER EXTRACTIONS FOR EXPORT
(in acre-feet)

Year	Alpaugh Irrigation District: Extractions: Node 23	Extractions: Node 35	Extractions: Total	Conveyance Losses: Deep Percolation: Node 8	Deep Percolation: Node 23	Evaporation: Node 8	Evaporation: Node 23	Total Losses	Exported
1958	6,212	3,106	9,318	1,440	847	118	68	2,473	6,845
1959	10,780	5,390	16,170	2,608	1,534	203	120	4,465	11,705
1960	10,772	5,361	16,133	2,485	1,462	203	119	4,269	11,864
1961	8,221	4,110	12,331	1,905	1,121	155	91	3,272	9,059
1962	9,140	4,570	13,710	2,118	1,246	173	101	3,638	10,072
1963	9,456	4,728	14,184	2,193	1,290	179	105	3,767	10,417
1964	12,881	6,440	19,321	2,985	1,756	243	143	5,127	14,194
1965	10,274	5,137	15,411	2,382	1,401	194	114	4,091	11,320
1966	12,235	6,118	18,353	2,837	1,669	231	136	4,873	13,480
Average 1958-66	10,000	5,000	15,000	2,300	1,400	200	100	4,000	11,000

Year	Lost Hills Water District: Extractions: Node 51	Lost Hills: Urban Use	Lost Hills: Exported	Belridge Oil Company: Extractions: Node 80	West Kern County Water District: Extractions: Node 157
1958	88	14	74	518	2,116
1959	88	14	74	583	2,918
1960	88	14	74	565	2,698
1961	88	14	74	513	2,722
1962	88	14	74	484	2,747
1963	88	14	74	548	2,876
1964	92	16	76	604	3,280
1965	143	24	119	741	4,270
1966	143	24	119	996	4,455
1967	175	28	147	1,271	--
1968	178	28	150	1,179	--
1969	113	18	95	1,146	--
1970	132	21	111	1,359	--
1971	155	25	130	--	--
Average 1958-66	101	16	84	600	3,100

APPENDIX C

GEOLOGIC DATA

C-040748

TABLE 33

SELECTED DATA FROM UNCONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Elevation (feet) Bottom	Area (acres)	Specific Yield (percent)	Moisture Deficiency[1/] (acre-feet)	Initial Water Elevation (feet)	Subsidence[2/] (feet)	Fraction Pumped in Upper Layer[3/]
1	318	-602	5,760	10.3	31,700	207	0.00	0.95
2	247	-753	5,760	8.1	28,800	204	0.00	0.95
3	215	-560	5,760	8.0	4,040	198	0.00	0.95
4	218	-362	5,760	8.1	0	192	0.00	0.58
5	218	-232	5,760	8.2	0	185	0.00	0.44
6	217	-83	5,760	8.4	0	178	0.00	0.35
7	215	-85	5,760	10.3	0	160	0.00	0.35
8	216	-24	5,760	8.6	0	147	0.00	0.20
9	227	27	5,760	8.8	0	160	0.00	0.20
10	243	-57	5,760	10.8	0	184	0.00	0.40
11	265	-51	5,760	9.8	0	183	0.00	0.30
12	310	90	5,760	10.0	0	224	0.00	0.25
13	368	98	5,760	10.0	0	279	0.00	0.20
14	462	-738	5,760	8.8	0	167	0.77	1.00[4/]
15	575	-425	7,680	8.7	0	255	1.33	1.00[4/]
16	600	-360	5,760	8.6	0	270	1.06	1.00[4/]
17	474	-829	5,760	8.4	0	154	0.69	1.00[4/]
18	367	102	5,760	8.6	0	212	0.00	0.40
19	307	27	5,760	9.3	0	197	0.00	0.31
20	287	2	5,760	9.2	0	194	0.00	0.31
21	263	-27	5,760	10.1	0	175	0.00	0.30
22	242	-33	5,760	8.6	0	162	0.00	0.35
23	217	-53	5,760	10.4	0	134	0.00	0.30
24	220	-21	5,760	11.5	0	153	0.00	0.70
25	222	-108	5,760	12.3	0	175	0.00	0.32
26	220	-215	5,760	11.5	0	185	0.00	0.40
27	224	-201	5,760	10.5	0	207	0.00	0.70
28	225	-415	5,760	10.3	26,300	206	0.00	0.65
29	295	-235	5,125	9.8	47,200	207	0.00	0.95
30	262	-238	6,444	9.8	70,800	206	0.00	0.95
31	231	-244	5,760	12.3	26,240	208	0.00	0.90
32	237	12	5,760	10.5	0	200	0.00	0.80
33	227	-37	5,760	10.6	0	172	0.00	0.50
34	225	-35	5,760	12.2	0	166	0.00	0.50
35	235	-25	5,760	11.5	0	165	0.00	0.35
36	255	-1	5,760	8.8	0	170	0.00	0.30
37	280	17	5,760	11.3	0	190	0.00	0.25
38	315	10	5,760	10.7	0	225	0.00	0.22
39	343	43	5,760	9.1	0	202	0.00	0.45
40	400	125	5,760	8.8	0	160	0.00	0.35
41	545	-555	5,760	8.4	0	160	0.96	1.00[4/]

TABLE 33 (continued)

SELECTED DATA FROM UNCONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Elevation (feet) Bottom	Area (acres)	Specific Yield (percent)	Moisture Deficiency 1/ (acre-feet)	Initial Water Elevation (feet)	Subsidence 2/ (feet)	Fraction Pumped in Upper Layer 3/
42	650	-13	5,760	8.2	0	360	0.57	1.00 4/
43	750	-100	5,760	8.1	0	360	0.80	1.00 4/
44	550	-600	5,760	8.4	0	160	1.47	1.00 4/
45	410	-1,090	5,760	8.6	0	163	0.62	1.00 4/
46	372	72	5,760	12.9	0	280	0.00	0.30
47	333	43	5,760	11.5	0	235	0.00	0.35
48	293	-27	5,760	9.2	0	192	0.00	0.35
49	268	-42	5,760	9.2	0	154	0.00	0.40
50	248	-117	5,760	11.5	0	175	0.00	0.40
51	240	-97	5,760	11.6	0	180	0.00	0.20
52	235	60	5,760	11.3	0	193	0.00	0.19
53	235	-85	5,760	11.4	0	190	0.00	0.95
54	248	-252	7,144	11.5	53,600	208	0.00	0.95
55	300	-135	5,760	9.3	57,600	215	0.00	0.80
56	235	-230	5,760	11.5	6,000	211	0.00	0.79
57	245	-215	5,760	12.1	0	202	0.00	0.45
58	264	-52	5,760	11.6	0	200	0.00	0.30
59	264	-51	5,760	11.4	0	182	0.00	0.33
60	282	2	5,760	9.4	0	170	0.00	0.30
61	315	35	5,760	9.6	0	180	0.00	0.40
62	350	60	5,760	9.8	0	220	0.00	0.35
63	368	112	5,760	13.2	0	279	0.00	0.50
64	435	-1,265	5,760	11.3	0	201	0.73	1.00 4/
65	590	-1,315	5,760	9.6	0	219	1.58	1.00 4/
66	700	-566	5,760	10.1	0	324	0.69	1.00 4/
67	525	-1,275	5,760	10.0	0	315	0.53	1.00 4/
68	485	-1,755	5,760	9.4	0	216	1.09	1.00 4/
69	450	-1,750	5,760	10.7	0	205	0.54	1.00 4/
70	395	60	5,760	9.7	0	240	0.00	0.32
71	355	15	5,760	9.9	0	210	0.00	0.45
72	317	-61	5,760	10.2	0	181	0.00	0.80
73	285	-49	5,760	10.5	0	198	0.00	0.22
74	282	-18	5,760	11.5	0	201	0.00	0.25
75	238	-151	5,760	12.9	0	208	0.00	0.37
76	250	-200	5,760	12.6	0	214	0.00	0.20
77	240	-185	5,760	12.4	12,650	226	0.00	0.68
78	340	-100	5,760	9.2	86,400	229	0.00	0.95
79	250	-190	5,760	11.3	16,950	224	0.00	0.49
80	252	-149	5,760	12.0	0	228	0.00	0.66
81	287	-128	5,760	12.6	0	227	0.00	0.63
82	257	-186	5,760	14.0	0	235	0.00	0.70

TABLE 33 (continued)

SELECTED DATA FROM UNCONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Elevation (feet) Bottom	Area (acres)	Specific Yield (percent)	Moisture Deficiency[1] (acre-feet)	Initial Water Elevation (feet)	Subsidence[2] (feet)	Fraction Pumped in Upper Layer[3]
83	295	-95	5,760	12.1	0	210	0.00	0.35
84	312	-107	5,760	10.5	0	174	0.00	0.65
85	337	-68	5,760	10.4	0	191	0.00	0.80
86	363	-37	5,760	10.6	0	211	0.00	0.70
87	412	40	5,760	10.0	0	240	0.00	0.50
88	440	-1,960	5,760	8.9	0	209	0.44	1.00[4]
89	640	-1,560	5,760	10.6	0	250	0.35	1.00[4]
91	700	-1,400	5,760	12.1	0	245	0.11	1.00[4]
92	510	-2,390	5,760	11.3	0	196	0.34	1.00[4]
93	378	78	5,760	11.4	0	281	0.00	0.23
94	354	-40	5,760	12.0	0	248	0.00	0.51
95	333	-56	5,760	12.3	0	231	0.00	0.77
96	318	-1	5,760	11.6	0	201	0.00	0.60
97	301	-105	5,760	11.5	0	200	0.00	0.50
98	270	-180	5,760	12.0	0	224	0.00	0.75
99	270	-156	5,760	12.5	0	227	0.00	0.63
100	247	-149	5,760	13.0	0	232	0.00	0.69
101	247	-193	5,760	13.6	800	228	0.00	0.80
102	280	-120	5,760	11.9	22,050	235	0.00	0.95
103	265	-195	5,760	13.6	18,850	230	0.00	0.95
104	263	-147	5,760	15.5	640	228	0.00	0.80
105	271	-161	5,760	14.0	0	237	0.00	0.60
106	289	-76	5,760	13.1	0	217	0.00	0.55
107	289	-123	5,760	12.7	0	211	0.00	0.90
108	308	-112	5,760	13.1	0	222	0.00	0.80
109	325	-108	5,760	12.9	0	230	0.00	0.96
110	336	-104	5,760	13.0	0	260	0.00	0.90
111	362	62	5,760	13.1	0	292	0.00	0.75
112	400	150	5,760	12.7	0	325	0.00	0.50
113	440	-2,160	5,760	12.8	0	261	0.34	1.00[4]
114	450	-1,250	5,760	13.3	0	331	0.08	1.00[4]
115	550	-350	5,760	13.2	0	370	0.00	1.00[4]
116	1,020	445	6,898	13.0	0	629	0.00	1.00[4]
117	835	-100	4,538	12.7	0	608	0.00	1.00[4]
118	815	-480	4,498	12.7	0	453	0.20	1.00[4]
120	540	-1,180	6,803	13.3	0	250	0.42	1.00[4]
121	420	-1,780	5,760	16.7	0	290	0.41	1.00[4]
122	400	180	5,760	16.8	0	358	0.00	0.62
123	380	130	5,760	16.9	0	331	0.00	0.65
124	360	0	5,760	18.1	0	304	0.00	1.00
125	340	-120	5,760	16.9	0	271	0.00	0.90

TABLE 33 (continued)

SELECTED DATA FROM UNCONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Elevation (feet) Bottom	Area (acres)	Specific Yield (percent)	Moisture Deficiency[1/] (acre-feet)	Initial Water Elevation (feet)	Subsidence[2/] (feet)	Fraction Pumped in Upper Layer[3/]
126	323	-37	5,760	15.1	0	244	0.00	0.95
127	308	-76	5,760	15.0	0	227	0.00	0.99
128	296	-69	5,760	14.1	0	233	0.00	0.99
129	277	-98	5,760	14.0	0	236	0.00	0.85
130	270	-155	5,760	15.6	7,900	239	0.00	0.95
131	290	-130	5,760	14.1	39,400	238	0.00	0.85
132	500	-140	4,500	13.3	7,600	245	0.00	0.90
133	290	-190	6,610	15.1	6,750	244	0.00	0.88
134	290	-90	5,760	15.2	2,050	248	0.00	0.98
135	302	-178	5,760	15.1	0	262	0.00	0.80
136	320	-100	5,760	16.1	0	277	0.00	0.95
137	337	-69	5,760	18.1	0	312	0.00	0.95
138	356	-29	5,760	19.5	0	323	0.00	0.95
139	370	-60	5,760	18.6	0	325	0.00	0.90
140	378	-22	5,760	18.6	0	314	0.00	0.90
141	378	143	5,760	16.5	0	307	0.00	0.38
142	380	-424	4,655	14.4	0	266	0.85	1.00[4/]
143	445	-255	5,894	13.9	0	232	0.67	1.00[4/]
144	520	-180	5,570	14.2	0	229	0.62	1.00[4/]
145	642	-262	5,900	14.9	0	215	0.30	1.00[4/]
146	640	-40	5,025	15.0	0	223	0.31	1.00[4/]
147	520	-280	5,880	16.7	0	210	0.40	1.00[4/]
148	505	-895	6,500	15.5	0	212	0.76	1.00[4/]
149	435	-1,165	5,435	14.8	0	226	0.99	1.00[4/]
150	366	-12	5,670	14.6	0	260	0.00	0.50
151	359	-81	5,760	16.7	0	305	0.00	0.84
152	352	-78	5,760	19.2	0	300	0.00	0.95
153	352	-48	5,760	18.7	0	301	0.00	0.95
154	338	-77	5,760	18.5	0	307	0.00	0.65
155	324	-78	5,760	18.2	0	304	0.00	0.95
156	314	-76	5,760	17.8	0	283	0.00	0.56
157	300	-80	5,680	15.1	5,600	260	0.00	0.96
158	490	-60	4,800	11.5	2,400	260	0.00	0.95
159	300	-135	5,440	13.0	12,800	265	0.00	0.60
160	297	-283	5,760	14.5	0	270	0.00	0.93
161	307	-268	5,760	16.1	0	276	0.00	0.95
162	318	-227	5,760	16.6	0	284	0.00	0.95
163	331	-194	5,760	16.9	0	289	0.00	0.99
164	335	-103	5,760	16.9	0	283	0.00	0.99
165	338	-88	5,760	16.3	0	301	0.00	0.85
166	362	-14	5,760	14.5	0	299	0.00	0.40

TABLE 33 (continued)

SELECTED DATA FROM UNCONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Elevation (feet) Bottom	Area (acres)	Specific Yield (percent)	Moisture Deficiency[1/] (acre-feet)	Initial Water Elevation (feet)	Subsidence[2/] (feet)	Fraction Pumped in Upper Layer[3/]
167	426	106	5,760	13.5	0	293	0.00	0.15
168	484	-816	6,300	15.1	0	209	0.60	1.00[4/]
169	435	35	4,680	14.4	0	274	0.00	0.20
170	384	-66	6,980	13.4	0	270	0.00	0.40
171	335	50	5,760	13.6	0	292	0.00	0.20
172	310	-55	5,760	13.9	0	302	0.00	0.40
173	304	-33	5,760	15.7	0	292	0.00	0.74
174	298	-172	5,760	15.6	0	273	0.00	0.90
175	295	-215	5,760	14.7	0	263	0.00	0.50
176	290	-260	5,760	12.1	0	259	0.00	0.75
177	284	-276	5,760	9.6	0	256	0.00	0.47
178	290	-260	5,760	9.6	320	275	0.00	0.95
179	315	-150	6,720	9.9	640	275	0.00	0.95
180	290	-250	5,760	12.0	0	286	0.00	0.80
181	290	-131	5,760	10.9	0	279	0.00	0.30
182	290	-330	5,760	13.6	0	280	0.00	0.90
183	290	-350	5,760	12.3	0	278	0.00	0.90
184	290	-135	5,760	12.6	0	265	0.00	0.60
185	283	-137	5,760	13.1	0	241	0.00	0.95
186	286	-149	5,760	12.1	0	282	0.00	0.80
187	330	-78	6,950	12.4	0	260	0.00	0.38
188	412	-58	7,035	14.4	0	251	0.00	0.33
189	405	-100	4,850	14.5	0	233	0.00	0.20
191	570	-130	5,600	12.3	0	270	0.00	1.00[4/]
192	560	-458	5,670	14.9	0	235	0.65	1.00[4/]
193	435	-45	5,900	13.4	0	270	0.00	0.20
194	390	-47	4,510	14.2	0	240	0.00	0.30
195	365	-75	6,525	11.5	0	263	0.00	0.20
196	285	-95	5,815	9.6	0	268	0.00	0.45
197	310	-110	5,755	10.9	0	278	0.00	0.36
198	352	-148	5,760	12.5	7,200	290	0.00	0.25
199	362	-238	5,760	11.7	44,000	275	0.00	1.00
200	360	-160	5,760	12.1	45,000	285	0.00	0.50
201	395	-175	7,680	12.1	57,600	279	0.00	0.58
202	585	135	6,750	12.2	188,000	290	0.00	0.15
203	525	35	6,665	13.0	109,000	280	0.00	0.30
204	520	-125	6,660	14.5	101,000	280	0.00	0.20
205	495	-125	6,820	15.5	59,000	275	0.00	0.25
206	460	-190	6,600	10.4	93,000	270	0.00	0.30
207	365	-235	5,080	9.7	30,950	275	0.00	0.20
208	500	0	6,670	12.9	4,200	272	0.00	0.10

TABLE 33 (continued)

SELECTED DATA FROM UNCONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Elevation (feet) Bottom	Area (acres)	Specific Yield (percent)	Moisture Deficiency 1/ (acre-feet)	Initial Water Elevation (feet)	Subsidence 2/ (feet)	Fraction Pumped in Upper Layer 3/
209	480	10	5,550	12.0	0	263	0.00	0.15
210	650	-950	6,070	12.9	0	265	0.48	1.00 4/
211	655	-305	5,390	12.5	0	270	0.20	1.00 4/
212	732	-252	7,540	14.7	0	281	0.00	1.00 4/
213	790	-610	7,010	15.5	0	285	0.10	1.00 4/
214	760	-442	8,510	15.4	9,600	283	0.30	1.00 4/
215	430	-140	6,005	10.5	75,300	290	0.00	0.15
216	700	-130	7,020	13.2	93,000	285	0.00	0.90
217	850	-80	7,545	12.2	60,000	285	0.00	0.90
218	940	-50	7,550	12.3	101,000	285	0.00	0.90
219	975	10	7,350	13.3	109,000	285	0.00	0.90
220	975	50	5,735	13.2	95,000	290	0.00	0.90

1/ Initial moisture deficiency in node.
2/ Subsidence over 15-year period 1958-72.
3/ Fraction of total amount pumped.
4/ Modeled as single-layer area.

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TABLE 34

SELECTED DATA FROM CONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Elevation (feet) Bottom	Area (acres)	Storage Coefficient (percent)	Initial Water Elevation (feet)	Subsidence[1/] (feet)	Fraction Pumped in Lower Layer[2/]
301	-657	-1,077	5,760	0.03	150	0.19	0.05
302	-853	-1,353	5,760	0.03	150	0.44	0.05
303	-685	-1,185	5,760	0.03	145	0.70	0.05
304	-452	-972	5,760	0.03	126	1.02	0.42
305	-332	-932	5,760	0.03	119	2.02	0.56
306	-183	-783	5,760	0.03	112	2.30	0.65
307	-135	-875	5,760	0.03	108	2.49	0.65
308	-84	-984	5,760	0.03	117	2.47	0.80
309	-118	-1,278	5,760	0.03	125	2.82	0.80
310	-147	-1,567	5,760	0.03	139	2.77	0.60
311	-85	-1,645	5,760	0.09	160	1.57	0.70
312	-20	-1,400	5,760	0.09	170	0.92	0.75
313	78	-1,042	5,760	0.09	162	0.52	0.80
318	67	-1,133	5,760	0.03	167	0.50	0.60
319	-23	-1,503	5,760	0.03	171	0.74	0.69
320	-63	-1,523	5,760	0.09	162	1.52	0.69
321	-92	-1,432	5,760	0.03	147	2.37	0.70
322	-98	-1,218	5,760	0.03	136	2.67	0.65
323	-103	-1,143	5,760	0.03	115	2.33	0.70
324	-100	-940	5,760	0.03	120	1.96	0.30
325	-158	-838	5,760	0.03	128	2.05	0.68
326	-275	-775	5,760	0.03	135	1.62	0.60
327	-301	-821	5,760	0.03	144	0.67	0.30
328	-595	-1,075	5,760	0.03	150	0.52	0.35
329	-455	-1,015	5,125	0.03	160	0.48	0.05
330	-388	-848	6,444	0.03	145	0.41	0.05
331	-369	-909	5,760	0.03	143	0.64	0.10
332	-108	-668	5,760	0.03	135	0.76	0.20
333	-133	-633	5,760	0.03	135	1.33	0.50
334	-130	-730	5,760	0.03	134	1.85	0.50
335	-120	-860	5,760	0.03	139	2.10	0.65
336	-90	-1,090	5,760	0.03	150	2.22	0.70
337	-70	-1,210	5,760	0.03	159	2.09	0.75
338	-42	-1,482	5,760	0.03	174	1.22	0.78
339	11	-1,509	5,760	0.03	203	0.62	0.55
340	95	-1,005	5,760	0.03	147	0.58	0.65
346	34	-1,326	5,760	0.03	202	0.53	0.70
347	23	-1,177	5,760	0.09	185	0.97	0.65
348	-52	-1,152	5,760	0.03	166	1.41	0.65
349	-112	-1,072	5,760	0.03	153	1.48	0.60
350	-152	-752	5,760	0.03	134	1.43	0.60
351	-140	-620	5,760	0.03	125	1.38	0.80

TABLE 34 (continued)

SELECTED DATA FROM CONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Bottom	Area (acres)	Storage Coefficient (percent)	Initial Water Elevation (feet)	Subsidence[1/] (feet)	Fraction Pumped in Lower Layer[2/]
352	-100	-520	5,760	0.03	115	1.01	0.81
353	-190	-590	5,760	0.03	135	0.44	0.05
354	-372	-772	7,144	0.03	150	0.65	0.05
355	-195	-595	5,760	0.03	165	0.40	0.20
356	-265	-665	5,760	0.03	140	0.37	0.21
357	-230	-630	5,760	0.03	120	0.66	0.55
358	-81	-581	5,760	0.03	117	0.64	0.70
359	-81	-681	5,760	0.03	128	0.79	0.67
360	-58	-918	5,760	0.09	153	0.69	0.70
361	-9	-1,089	5,760	0.03	162	0.82	0.60
362	40	-1,100	5,760	0.03	185	0.77	0.65
363	88	-1,252	5,760	0.03	196	0.54	0.50
370	25	-1,195	5,760	0.09	204	0.39	0.68
371	-55	-1,095	5,760	0.03	188	0.44	0.55
372	-101	-1,041	5,760	0.09	170	0.59	0.20
373	-60	-760	5,760	0.03	134	0.54	0.78
374	-38	-438	5,760	0.03	128	0.74	0.75
375	-212	-572	5,760	0.03	128	0.79	0.63
376	-250	-690	5,760	0.03	145	0.74	0.80
377	-225	-665	5,760	0.03	165	0.45	0.32
378	-125	-465	5,760	0.03	175	0.30	0.05
379	-230	-630	5,760	0.03	180	0.26	0.51
380	-193	-633	5,760	0.03	170	0.56	0.34
381	-158	-498	5,760	0.03	145	0.67	0.37
382	-214	-734	5,760	0.03	140	0.66	0.30
383	-145	-505	5,760	0.03	143	0.49	0.65
384	-138	-538	5,760	0.09	150	0.38	0.35
385	-115	-855	5,760	0.09	185	0.33	0.20
386	-81	-1,081	5,760	0.03	197	0.28	0.30
387	0	-1,438	5,760	0.03	210	0.28	0.50
393	3	-2,522	5,760	0.09	219	0.39	0.77
394	-100	-1,596	5,760	0.03	220	0.21	0.49
395	-112	-1,072	5,760	0.03	200	0.26	0.23
396	-82	-782	5,760	0.03	188	0.26	0.40
397	-138	-558	5,760	0.03	175	0.32	0.50
398	-208	-728	5,760	0.03	173	0.36	0.25
399	-180	-480	5,760	0.03	175	0.60	0.37
400	-173	-663	5,760	0.03	180	0.46	0.31
401	-223	-643	5,760	0.03	185	0.26	0.20
402	-190	-550	5,760	0.03	190	0.21	0.05
403	-240	-780	5,760	0.03	210	0.15	0.05
404	-197	-777	5,760	0.03	205	0.22	0.20

TABLE 34 (continued)

SELECTED DATA FROM CONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Elevation (feet) Bottom	Area (acres)	Storage Coefficient (percent)	Initial Water Elevation (feet)	Subsidence[1/] (feet)	Fraction Pumped in Lower Layer[2/]
405	-179	-679	5,760	0.03	176	0.40	0.40
406	-111	-551	5,760	0.03	193	0.34	0.45
407	-163	-603	5,760	0.03	201	0.34	0.10
408	-150	-690	5,760	0.03	203	0.34	0.20
409	-132	-972	5,760	0.03	216	0.34	0.04
410	-130	-1,863	5,760	0.03	225	0.35	0.10
411	-38	-2,538	5,760	0.09	234	0.35	0.25
412	100	-2,900	5,760	0.12	265	0.35	0.50
422	130	-3,000	5,760	0.12	307	0.38	0.38
423	30	-3,020	5,760	0.09	290	0.36	0.35
424	-110	-2,040	5,760	0.09	270	0.42	0.00
425	-130	-1,650	5,760	0.09	242	0.40	0.10
426	-134	-894	5,760	0.09	218	0.34	0.05
427	-117	-977	5,760	0.03	230	0.31	0.01
428	-99	-639	5,760	0.03	215	0.20	0.01
429	-173	-673	5,760	0.03	214	0.20	0.15
430	-195	-755	5,760	0.09	225	0.15	0.05
431	-160	-880	5,760	0.09	230	0.15	0.15
432	-170	-400	4,500	0.02	230	0.10	0.10
433	-210	-510	6,610	0.03	235	0.14	0.12
434	-180	-520	5,760	0.03	237	0.26	0.02
435	-198	-738	5,760	0.03	238	0.31	0.20
436	-130	-970	5,760	0.03	250	0.37	0.05
437	-93	-1,253	5,760	0.03	268	0.42	0.05
438	-54	-1,934	5,760	0.09	290	0.42	0.05
439	-110	-3,530	5,760	0.03	288	0.37	0.10
440	-52	-3,622	5,760	0.03	285	0.42	0.10
441	18	-1,722	5,760	0.09	269	0.53	0.62
450	-35	-1,535	5,670	0.09	238	1.36	0.50
451	-121	-2,241	5,760	0.03	260	1.12	0.16
452	-108	-3,448	5,760	0.03	270	0.65	0.05
453	-98	-3,098	5,760	0.03	275	0.59	0.05
454	-172	-2,612	5,760	0.09	280	0.54	0.35
455	-176	-1,676	5,760	0.09	270	0.48	0.05
456	-126	-1,286	5,760	0.03	255	0.43	0.44
457	-150	-890	5,680	0.03	240	0.38	0.04
458	-120	-450	4,800	0.03	238	0.17	0.05
459	-200	-600	5,440	0.03	231	0.21	0.40
460	-348	-948	5,760	0.03	240	0.36	0.07
461	-303	-1,683	5,760	0.09	240	0.58	0.05
462	-272	-2,072	5,760	0.09	250	0.69	0.05
463	-209	-2,369	5,760	0.03	250	0.69	0.01

TABLE 34 (continued)

SELECTED DATA FROM CONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Bottom	Area (acres)	Storage Coefficient (percent)	Initial Water Elevation (feet)	Subsidence[1/] (feet)	Fraction Pumped in Lower Layer[2/]
464	-122	-2,962	5,760	0.03	250	0.85	0.01
465	-58	-2,618	5,760	0.12	240	1.46	0.15
466	-43	-1,943	5,760	0.03	220	2.12	0.60
467	76	-1,464	5,760	0.09	195	1.40	0.85
469	-15	-1,215	4,680	0.11	190	1.05	0.80
470	-91	-1,311	6,980	0.10	205	2.07	0.60
471	-5	-1,465	5,760	0.09	200	2.71	0.80
472	-95	-1,895	5,760	0.03	210	2.55	0.60
473	-171	-1,691	5,760	0.09	230	1.48	0.26
474	-203	-1,503	5,760	0.03	240	1.01	0.10
475	-260	-1,560	5,760	0.03	240	0.91	0.50
476	-300	-1,800	5,760	0.03	230	0.80	0.25
477	-311	-1,111	5,760	0.03	220	0.46	0.53
478	-340	-1,000	5,760	0.03	220	0.16	0.05
479	-245	-785	6,720	0.03	240	0.00	0.05
480	-310	-1,030	5,760	0.03	200	0.22	0.20
481	-260	-1,200	5,760	0.09	200	0.70	0.70
482	-375	-1,315	5,760	0.09	200	1.01	0.10
483	-380	-1,500	5,760	0.03	210	1.44	0.10
484	-210	-1,410	5,760	0.03	210	2.07	0.40
485	-207	-1,307	5,760	0.09	190	3.01	0.05
486	-204	-1,204	5,760	0.09	180	3.57	0.20
487	-128	-1,228	6,950	0.03	170	3.18	0.62
488	-78	-1,378	7,035	0.03	160	1.50	0.67
489	-127	-1,195	4,850	0.10	180	0.89	0.80
493	-82	-1,762	5,900	0.10	140	1.78	0.80
494	-138	-1,518	4,510	0.11	130	3.04	0.70
495	-185	-2,125	6,525	0.09	140	3.71	0.80
496	-205	-1,465	5,815	0.03	150	4.34	0.55
497	-238	-1,198	5,755	0.03	150	3.95	0.64
498	-228	-1,448	5,760	0.03	150	2.41	0.75
499	-286	-1,126	5,760	0.09	145	1.32	0.00
500	-280	-1,020	5,760	0.03	150	0.86	0.50
501	-215	-915	7,680	0.03	155	0.37	0.42
502	25	-415	6,750	0.03	150	0.21	0.85
503	-65	-985	6,665	0.03	140	0.40	0.70
504	-155	-1,595	6,660	0.03	115	0.53	0.80
505	-155	-1,615	6,820	0.03	105	1.10	0.75
506	-210	-1,350	6,600	0.03	105	3.09	0.70
507	-305	-1,385	5,080	0.10	100	4.12	0.80
508	-30	-2,010	6,670	0.03	100	2.09	0.90
509	-30	-2,630	5,550	0.03	110	1.79	0.85

TABLE 34 (continued)

SELECTED DATA FROM CONFINED AQUIFER NODES
DATA BASE FOR RUN 'A'
May 30, 1974

Node No.	Elevation (feet) Top	Elevation (feet) Bottom	Area (acres)	Storage Coefficient (percent)	Initial Water Elevation (feet)	Subsidence 1/ (feet)	Fraction Pumped in Lower Layer 2/
515	-180	-1,780	6,005	0.08	110	2.60	0.85
516	-170	-3,000	7,020	0.03	110	0.59	0.10
517	-130	-2,360	7,545	0.03	120	0.27	0.10
518	-110	-1,460	7,550	0.09	120	0.21	0.10
519	-60	-1,220	7,350	0.03	130	0.16	0.10
520	-20	-1,000	5,735	0.03	140	0.07	0.10

1/ Subsidence over 15-year period 1958-72.
2/ Fraction of total amount pumped.

TABLE 35

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
1	2	282.5	-677.5	15,900	15,900	0.224	215.2
1	221 1/	284.5	-701.0	16,000	16,200	0.257	250.0
2	3	231.0	-656.5	15,800	15,900	0.179	158.2
2	29	271.0	-494.0	16,200	15,800	0.280	219.8
2	222 1/	233.0	-801.5	16,100	16,400	0.224	227.5
3	4	216.5	-461.0	15,900	16,400	0.146	95.7
3	28	220.0	-487.5	16,100	16,300	0.143	100.0
3	223 1/	211.0	-680.0	16,300	16,300	0.112	100.0
4	5	218.0	-297.0	16,400	16,500	0.191	97.5
4	27	221.0	-281.5	16,300	15,800	0.096	50.0
4	224 1/	213.0	-451.0	16,300	16,400	0.151	99.7
5	6	217.5	-157.5	16,100	16,000	0.133	50.0
5	26	219.0	-223.0	16,500	16,200	0.155	70.0
5	225 1/	212.5	-296.0	16,700	16,300	0.157	81.8
6	7	216.0	-84.0	16,100	16,200	0.336	100.3
6	25	219.5	-95.5	16,400	16,000	0.336	108.6
6	226 1/	213.0	-186.5	16,200	16,300	0.078	31.0
7	8	215.5	-54.5	16,600	15,700	0.426	121.6
7	24	217.5	-53.0	15,900	16,000	0.504	135.6
7	227 1/	211.0	-137.5	15,900	16,600	0.336	112.2
8	9	221.5	1.5	16,000	16,200	0.322	70.0
8	23	216.5	-38.5	16,000	15,900	0.336	86.3
8	228 1/	210.0	-82.0	15,900	16,400	0.392	111.0
9	10	235.0	-15.0	16,100	16,000	0.060	15.0
9	22	234.5	-3.0	16,400	16,000	0.213	51.8
9	229 1/	221.0	-76.5	16,300	15,600	0.179	55.6
10	11	254.0	-54.0	16,100	16,400	0.397	120.0
10	21	253.0	-42.0	16,400	16,200	0.067	20.0
10	230 1/	239.0	-108.5	16,300	16,100	0.057	20.0
11	12	287.5	19.5	16,000	16,600	0.077	20.0
11	20	276.0	-24.5	15,900	16,000	0.268	80.0
11	231 1/	265.5	-80.5	15,800	16,000	0.234	80.0
12	13	339.0	94.0	15,800	15,600	0.201	50.0
12	19	308.5	58.5	16,300	16,300	0.080	20.0
12	232 1/	307.5	30.0	16,200	15,500	0.448	130.0
13	14	400.0	130.0	15,800	15,900	0.037	10.0
13	18	367.5	100.0	16,100	16,100	0.112	30.0
13	233 1/	370.0	69.0	16,100	16,100	0.233	70.0
14	15	518.5	-581.5	15,900	16,000	0.183	200.0
14	17	468.0	-783.5	16,300	16,200	0.079	100.0
14	234 1/	453.5	-744.0	16,100	15,800	0.287	350.0
15	16	587.5	-392.5	15,800	16,100	0.104	100.0

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Perme-ability	Conduc-tivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
15	235[1/]	536.0	-437.5	21,100	15,900	0.077	100.0
16	17	537.0	-594.5	16,100	16,000	0.004	5.0
16	42	625.0	-186.5	16,000	15,800	0.061	50.0
17	18	420.0	130.0	16,300	16,300	0.034	10.0
17	41	509.5	-692.0	16,200	15,800	0.057	70.0
18	19	337.0	64.5	16,100	16,100	0.367	100.0
18	40	383.5	113.5	16,000	15,800	0.073	20.0
19	20	297.0	14.5	16,100	16,200	0.748	210.0
19	39	325.0	35.0	16,400	16,000	0.291	86.6
20	21	275.0	-12.5	16,000	16,100	0.053	15.0
20	38	301.0	6.0	16,000	15,900	0.336	99.8
21	22	252.5	-30.0	16,500	16,400	0.281	80.0
21	37	271.5	-5.0	16,300	16,000	0.320	90.0
22	23	229.5	-43.0	16,100	16,000	0.219	60.0
22	36	248.5	-17.0	16,400	16,100	0.269	72.8
23	24	218.5	-37.0	16,100	15,800	0.448	116.7
23	35	226.0	-39.0	16,100	16,200	0.266	70.0
24	25	221.0	-64.5	16,100	16,200	0.352	100.0
24	34	222.5	-28.0	16,000	16,200	0.202	50.0
25	26	221.0	-161.5	16,100	16,300	0.238	90.0
25	33	224.5	-72.5	16,300	16,500	0.560	164.4
26	27	222.0	-208.0	16,000	16,300	0.047	20.0
26	32	228.5	-101.5	16,400	16,400	0.212	70.0
27	28	224.5	-308.0	16,100	16,300	0.513	270.0
27	31	227.5	-222.5	16,300	16,400	0.425	190.0
28	29	260.0	-325.0	16,100	15,900	0.381	225.8
28	30	243.5	-326.5	16,200	16,100	0.336	192.9
29	30	278.5	-236.5	5,100	22,800	0.347	40.0
30	31	246.5	-241.0	16,200	16,100	0.460	225.4
30	54	255.0	-245.0	8,500	22,600	0.325	61.1
31	32	234.0	-116.0	16,400	16,400	0.171	60.0
31	54	239.5	-248.0	16,100	15,500	0.549	278.1
32	33	232.0	-12.5	16,300	16,200	0.285	70.0
32	53	236.0	-36.5	16,400	15,800	0.212	60.0
33	34	226.0	-36.0	16,400	16,400	0.458	120.0
33	52	231.0	11.5	16,300	16,000	0.224	50.0
34	35	230.0	-30.0	16,400	16,000	0.594	158.3
34	51	232.5	-66.0	16,100	16,500	0.172	50.0
35	36	245.0	-13.0	16,100	16,000	0.385	100.0
35	50	241.5	-71.0	15,900	16,400	0.527	159.6
36	37	267.5	8.0	16,300	16,300	0.426	110.5
36	49	261.5	-21.5	16,300	16,400	0.291	82.0

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
37	38	297.5	13.5	16,100	16,200	0.071	20.0
37	48	286.5	-5.0	16,400	16,000	0.067	20.0
38	39	329.0	26.5	15,900	16,000	0.998	300.0
38	47	324.0	26.5	16,200	16,200	0.303	90.0
39	40	371.5	84.0	15,900	16,500	0.180	50.0
39	46	357.5	57.5	16,400	16,100	0.295	90.0
40	41	470.0	130.0	15,900	16,200	0.060	20.0
40	45	400.0	150.0	16,100	15,900	0.158	40.0
41	42	597.5	-284.0	15,900	15,800	0.006	5.0
41	44	547.5	-577.5	16,400	16,000	0.087	100.0
42	43	700.0	-56.5	15,800	16,000	0.135	100.5
43	44	650.0	-350.0	16,100	16,100	0.005	5.0
43	66	725.0	-333.0	15,800	16,100	0.048	50.0
44	45	480.0	-845.0	16,300	16,200	0.075	100.0
44	65	570.0	-957.5	16,500	16,100	0.096	150.0
45	46	390.0	130.0	16,200	16,500	0.588	150.0
45	64	422.5	-1,177.5	16,300	16,400	0.224	356.5
46	47	352.5	57.5	16,400	15,900	0.560	170.5
46	63	380.0	92.0	16,300	16,100	0.069	20.0
47	48	313.0	8.0	16,300	16,100	0.259	80.0
47	62	341.5	51.5	16,100	16,100	0.241	70.0
48	49	280.5	-34.5	16,400	16,400	0.381	120.0
48	61	304.0	4.0	16,300	16,200	0.280	84.6
49	50	258.0	-79.5	16,100	16,000	0.177	60.0
49	60	275.0	-20.0	16,300	16,200	0.235	69.9
50	51	244.0	-107.0	16,000	15,800	0.169	60.0
50	59	256.0	-84.0	15,800	16,000	0.527	176.9
51	52	237.5	-18.5	16,000	15,800	0.426	110.4
51	58	252.0	-74.5	16,100	15,900	0.549	181.6
52	53	235.0	-12.5	15,800	16,200	0.249	60.0
52	57	240.0	-77.5	16,200	16,300	0.222	70.0
53	54	241.5	-168.5	15,900	16,400	0.426	169.3
53	56	235.0	-157.5	16,400	16,500	0.504	196.8
54	55	274.0	-193.5	15,900	16,500	0.370	166.6
55	56	267.5	-182.5	16,600	16,300	0.437	200.3
55	78	320.0	-117.5	16,000	16,300	0.291	125.2
56	57	240.0	-222.5	16,600	16,200	0.583	276.2
56	77	237.5	-207.5	16,500	16,200	0.370	167.7
57	58	254.5	-133.5	16,100	16,300	0.261	100.0
57	76	247.5	-207.5	16,300	16,000	0.482	223.4
58	59	264.0	-51.5	16,500	15,900	0.572	187.2
58	75	251.0	-101.5	16,100	16,200	0.285	100.0

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
59	60	273.0	-24.5	16,300	16,300	0.235	70.0
59	74	273.0	-34.5	15,800	15,900	0.460	140.4
60	61	298.5	18.5	16,100	16,100	0.269	75.3
60	73	283.5	-23.5	16,400	16,200	0.381	118.5
61	62	332.5	47.5	16,000	16,400	0.360	100.0
61	72	316.0	-13.0	16,300	16,200	0.314	103.9
62	63	369.0	86.0	16,200	16,000	0.384	110.0
62	71	352.5	37.5	16,300	16,200	0.359	113.7
63	64	410.0	130.0	16,100	16,500	0.732	200.0
63	70	391.5	86.0	16,500	16,300	0.491	152.0
64	65	512.5	-1,290.0	16,100	16,400	0.226	400.0
64	69	442.5	-1,507.5	16,300	16,300	0.314	612.0
65	66	645.0	-940.5	16,300	16,000	0.025	40.0
65	68	537.5	-1,535.0	16,600	16,300	0.142	300.0
66	67	612.5	-920.5	15,800	16,400	0.415	612.6
67	68	505.0	-1,515.0	16,200	16,000	0.034	70.0
67	89	582.5	-1,417.5	15,800	15,900	0.050	100.0
68	69	467.5	-1,752.5	16,300	16,500	0.365	800.0
68	88	462.5	-1,857.5	16,600	15,900	0.103	250.0
69	70	420.0	70.0	16,100	16,400	0.582	200.0
69	87	430.0	100.0	16,300	16,000	0.336	113.1
70	71	375.0	37.5	16,000	16,300	0.906	300.0
70	86	379.0	11.5	16,400	16,100	0.187	70.0
71	72	336.0	-23.0	15,900	16,500	0.578	200.0
71	85	346.0	-26.5	16,300	16,200	0.213	80.0
72	73	301.0	-55.0	15,900	15,900	0.370	131.7
72	84	314.5	-84.0	16,300	16,100	0.280	113.1
73	74	283.5	-33.5	15,700	16,300	0.164	50.0
73	83	290.0	-72.0	16,400	15,900	0.402	150.0
74	75	260.0	-84.5	15,800	15,900	0.351	120.0
74	82	269.5	-102.0	15,800	16,000	0.136	50.0
75	76	244.0	-175.5	15,900	16,400	0.516	209.7
75	81	262.5	-139.5	16,200	15,600	0.617	257.4
76	77	245.0	-192.5	15,900	16,100	0.594	256.7
76	80	251.0	-174.5	16,300	15,800	0.448	196.8
77	78	290.0	-142.5	15,800	16,200	0.560	236.4
77	79	245.0	-187.5	16,400	16,000	0.684	303.1
79	80	251.0	-169.5	15,800	16,100	0.538	222.0
79	102	265.0	-155.0	16,000	16,000	0.695	291.9
80	81	269.5	-138.5	16,000	16,100	0.538	218.2
80	101	249.5	-171.0	16,300	16,400	0.650	271.7
81	82	272.0	-157.0	15,900	16,000	0.673	286.7

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
81	100	267.0	-138.5	16,000	16,400	0.617	243.9
82	83	276.0	-140.5	16,000	16,000	0.120	50.0
82	99	263.5	-171.0	16,000	15,900	0.740	323.5
83	84	303.5	-101.0	16,000	16,100	0.249	100.0
83	98	282.5	-137.5	16,100	15,900	0.353	150.0
84	85	324.5	-87.5	16,300	16,600	0.494	200.0
84	97	306.5	-106.0	16,400	16,100	0.238	100.0
85	86	350.0	-52.5	16,100	16,200	0.700	280.0
85	96	327.5	-34.5	16,000	16,100	0.280	100.8
86	87	387.5	1.5	16,200	16,300	0.261	100.0
86	95	348.0	-46.5	16,400	16,300	0.572	226.9
87	88	420.0	110.0	16,100	16,200	0.162	50.0
87	94	383.0	0.0	16,100	16,400	0.532	200.0
88	89	540.0	-1,760.0	16,300	16,100	0.021	50.0
88	93	410.0	120.0	16,400	16,400	0.172	50.0
89	92	575.0	-1,975.0	16,100	16,600	0.020	50.0
91	92	605.0	-1,895.0	16,600	16,200	0.039	100.0
91	113	570.0	-1,780.0	16,200	16,000	0.000	1.0
92	93	440.0	180.0	16,600	16,100	0.187	50.0
92	112	390.0	210.0	16,000	16,400	0.285	50.0
93	94	366.0	19.0	16,600	16,200	0.844	300.0
93	111	370.0	70.0	16,300	16,400	0.335	100.0
94	95	343.5	-48.0	16,300	16,000	0.637	253.9
94	110	345.0	-72.0	15,900	15,800	0.238	100.0
95	96	325.5	-28.5	16,100	16,200	0.482	169.6
95	109	329.0	-82.0	16,400	15,800	0.234	100.0
96	97	309.5	-53.0	15,800	16,100	0.437	155.5
96	108	313.0	-56.5	15,700	15,900	0.516	188.1
97	98	285.5	-142.5	15,700	16,200	0.241	100.0
97	107	295.0	-114.0	16,400	15,800	0.589	250.0
98	99	270.0	-168.0	15,800	16,100	0.639	274.6
98	106	279.5	-128.0	16,000	15,900	0.717	294.2
99	100	258.5	-152.5	16,100	16,200	0.695	283.9
99	105	270.5	-158.5	16,300	16,100	0.576	250.0
100	101	247.0	-171.0	16,300	15,700	0.740	321.1
100	104	255.0	-148.0	15,800	16,000	0.852	339.0
101	102	263.5	-156.5	16,400	16,300	0.818	345.8
101	103	256.0	-194.0	16,200	15,800	0.802	370.0
103	104	264.0	-171.0	15,900	16,300	0.919	390.0
104	105	267.0	-154.0	16,100	16,100	0.897	377.5
104	131	276.5	-138.5	15,900	15,900	1.020	423.3
105	106	280.0	-118.5	16,400	16,200	0.099	40.0

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
105	130	270.5	-158.0	16,200	16,300	0.897	381.9
106	107	289.0	-99.5	16,600	16,500	0.256	100.0
106	129	283.0	-87.0	16,600	16,300	0.265	100.0
107	108	298.5	-117.5	16,500	16,300	0.583	245.5
107	128	292.5	-96.0	16,400	16,600	0.628	240.9
108	109	316.5	-110.0	16,300	16,300	0.234	100.0
108	127	308.0	-94.0	16,100	16,400	0.507	200.0
109	110	330.5	-106.0	16,300	16,400	0.231	100.0
109	126	324.0	-72.5	16,600	16,400	0.617	247.4
110	111	349.0	-21.0	16,200	16,100	0.537	200.0
110	125	338.0	-112.0	16,100	16,200	0.358	160.0
111	112	381.0	106.0	16,300	16,500	1.104	300.0
111	124	361.0	31.0	16,500	15,800	0.290	100.0
112	113	420.0	200.0	16,100	16,000	0.090	20.0
112	123	390.0	140.0	16,200	15,800	1.053	270.0
113	114	445.0	-1,705.0	16,100	16,300	0.005	10.0
113	122	420.0	210.0	16,500	16,200	0.234	50.0
114	115	500.0	-800.0	16,400	16,300	1.070	1,400.0
114	121	435.0	-1,515.0	16,200	16,600	0.473	900.0
115	120	545.0	-765.0	16,500	16,200	0.001	1.0
116	117	927.5	172.5	16,450	13,700	0.552	500.0
116	146	830.0	202.5	18,700	12,200	0.031	30.0
117	118	825.0	-290.0	15,850	11,000	0.009	15.0
117	145	738.5	-181.0	16,100	12,500	0.017	20.0
118	144	667.5	-330.0	16,750	18,950	0.057	50.0
120	121	480.0	-1,480.0	16,300	16,300	0.003	5.0
120	142	460.0	-802.0	14,500	16,500	0.009	10.0
120	143	492.5	-717.5	10,800	18,000	0.372	270.0
121	122	410.0	200.0	16,500	16,400	0.095	20.0
121	141	400.0	190.0	16,200	16,300	0.719	150.0
122	123	390.0	155.0	16,300	16,300	0.426	100.0
122	140	389.0	79.0	16,500	16,500	1.613	500.0
123	124	370.0	65.0	16,200	16,300	0.693	210.0
123	139	375.0	35.0	16,200	16,100	1.812	620.0
124	125	350.0	-60.0	16,200	16,400	0.247	100.0
124	138	358.0	-14.5	16,500	16,200	0.817	310.0
125	126	331.5	-78.5	16,200	16,600	0.250	100.0
125	137	338.5	-94.5	16,200	16,200	0.231	100.0
126	127	315.5	-56.5	16,300	16,200	0.267	100.0
126	136	321.5	-68.5	16,600	16,300	0.252	100.0
127	128	302.0	-72.5	16,300	16,200	0.908	342.1
127	135	305.0	-127.0	16,300	16,200	0.690	300.0

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
128	129	286.5	-83.5	16,300	16,300	0.270	100.0
128	134	293.0	-79.5	16,200	16,400	0.544	200.0
129	130	273.5	-126.5	16,200	16,300	0.377	150.0
129	133	283.5	-144.0	16,300	16,100	0.416	180.0
130	131	280.0	-142.5	16,400	16,200	1.020	436.3
130	132	380.0	-160.0	16,100	16,000	0.368	200.0
132	133	380.0	-180.0	16,400	16,100	0.351	200.0
133	134	290.0	-140.0	16,200	16,200	0.465	200.0
133	158	390.0	-125.0	7,200	22,500	0.243	40.0
134	135	296.0	-134.0	16,100	16,200	0.468	200.0
134	158	380.0	-80.0	16,300	15,800	0.316	150.0
135	136	311.0	-139.0	16,100	16,400	0.453	200.0
135	157	301.0	-129.0	16,200	16,400	0.471	200.0
136	137	328.5	-84.5	16,200	16,500	0.740	300.0
136	156	317.0	-88.0	16,600	16,300	1.455	600.0
137	138	346.5	-49.0	16,300	16,500	1.099	429.2
137	155	330.5	-73.5	16,200	16,700	1.786	700.0
138	139	363.0	-44.5	16,400	16,300	0.854	350.0
138	154	347.0	-53.0	16,500	16,300	1.729	700.0
139	140	374.0	-41.0	16,300	16,400	1.091	450.0
139	153	361.0	-54.0	16,200	16,600	0.914	370.0
140	141	378.0	60.5	16,300	16,400	0.634	200.0
140	152	365.0	-50.0	16,500	16,200	0.757	320.0
141	142	380.0	185.0	16,300	15,900	0.850	170.0
141	151	368.5	31.0	16,200	16,300	0.894	300.0
142	143	412.5	-339.5	15,900	10,000	0.084	100.0
142	150	370.0	180.0	12,300	16,300	0.349	50.0
143	144	482.5	-217.5	19,850	13,000	0.094	100.0
143	149	440.0	-710.0	6,250	19,850	0.166	60.0
143	150	400.0	120.0	4,250	19,400	0.617	37.8
144	145	581.0	-221.0	13,900	15,800	0.785	553.6
144	149	477.5	-672.5	14,500	12,400	0.841	1,130.6
145	146	641.0	-151.0	13,400	15,100	0.676	474.9
145	148	573.5	-578.5	12,500	18,400	0.639	500.0
145	149	538.5	-713.5	6,200	18,900	0.874	359.1
146	147	580.0	-160.0	17,700	12,900	0.367	400.0
146	148	572.5	-467.5	3,300	19,800	0.717	124.2
147	148	512.5	-587.5	11,700	15,300	0.238	200.0
147	168	502.0	-548.0	12,700	12,200	0.285	600.0
148	149	470.0	-1,030.0	4,100	21,000	0.427	125.0
148	167	460.0	170.0	16,500	17,200	0.072	20.0
148	168	494.5	-855.5	3,100	17,900	0.807	188.7

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
148	169	460.0	140.0	14,600	15,500	0.017	5.0
149	150	400.0	100.0	14,000	18,400	0.526	120.0
149	167	470.0	160.0	16,800	14,600	0.449	160.0
150	151	362.5	-46.5	16,600	16,000	0.118	50.0
150	166	364.0	-13.0	16,400	16,000	0.129	50.0
151	152	355.5	-79.5	16,600	16,300	0.564	250.0
151	165	348.5	-84.5	16,100	16,200	0.697	300.0
152	153	352.0	-63.0	16,600	16,300	0.828	350.0
152	164	343.5	-90.5	16,600	16,400	0.683	300.0
153	154	345.0	-62.5	16,500	16,500	0.919	374.6
153	163	341.5	-121.0	16,300	16,400	0.653	300.0
154	155	331.0	-77.5	16,600	16,500	0.730	300.0
154	162	328.0	-152.0	16,300	16,400	0.587	280.0
155	156	319.0	-77.0	16,700	16,200	0.490	200.0
155	161	315.5	-173.0	16,400	16,300	0.807	396.7
156	157	307.0	-78.0	16,500	16,200	0.510	200.0
156	160	305.5	-179.5	16,600	16,400	0.611	300.0
157	158	360.0	-70.0	16,400	16,000	0.182	80.0
157	159	300.0	-107.5	16,100	16,500	0.377	150.0
159	160	298.5	-209.0	16,300	16,000	0.717	370.9
159	178	295.0	-197.5	16,200	16,100	0.182	90.0
160	161	302.0	-275.5	16,200	16,400	0.526	300.0
160	177	290.5	-279.5	16,300	16,200	0.262	150.0
161	162	312.5	-247.5	16,100	16,700	0.370	200.0
161	176	298.5	-264.0	16,500	16,300	0.572	325.5
162	163	324.5	-210.5	16,300	16,400	0.628	333.8
162	175	306.5	-221.0	16,300	16,100	0.617	329.3
163	164	333.0	-148.5	16,100	16,400	0.635	300.0
163	174	314.5	-183.0	16,300	16,300	0.751	373.6
164	165	336.5	-95.5	16,000	16,400	0.166	70.0
164	173	319.5	-68.0	16,500	16,500	0.516	200.0
165	166	350.0	-51.0	16,100	16,100	0.175	70.0
165	172	324.0	-71.5	16,100	16,000	0.930	370.0
166	167	394.0	46.0	16,200	16,700	0.889	300.0
166	171	348.5	18.0	16,400	16,300	0.211	70.0
167	170	405.0	20.0	16,800	16,000	0.495	200.0
168	169	460.0	110.0	8,500	17,200	0.717	124.1
168	189	444.5	-90.0	10,900	16,100	0.276	100.0
169	170	409.5	-15.5	15,900	15,400	0.605	265.6
169	188	423.5	-11.5	2,800	20,700	0.729	42.9
169	189	420.0	120.0	16,000	11,300	0.589	250.0
170	171	359.5	-8.0	16,000	15,900	0.541	200.0
170	187	357.0	-72.0	7,300	22,200	0.560	79.1

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
170	188	398.0	-62.0	13,000	18,400	0.154	50.0
171	172	322.5	-2.5	16,100	16,000	0.612	200.0
171	187	332.5	-14.0	16,400	16,200	0.428	150.0
172	173	307.0	-44.0	16,000	16,100	0.201	70.0
172	186	298.0	-102.5	16,000	16,500	0.258	100.0
173	174	301.0	-102.0	16,400	16,500	0.499	200.0
173	185	293.5	-85.0	16,400	15,900	0.384	150.0
174	175	296.5	-193.5	16,400	16,100	0.501	250.0
174	184	294.0	-153.5	16,200	16,200	0.538	240.8
175	176	292.5	-237.5	16,400	16,500	0.628	330.7
175	183	292.5	-282.5	16,400	16,300	0.173	100.0
176	177	287.0	-268.0	16,200	16,100	0.370	206.6
176	182	290.0	-295.0	16,300	16,100	0.169	100.0
177	178	287.0	-268.0	16,400	15,800	0.202	116.2
177	181	287.0	-203.5	16,000	16,200	0.314	152.1
178	179	302.5	-205.0	16,500	17,800	0.106	50.0
178	180	290.0	-255.0	16,400	16,200	0.336	185.5
180	181	290.0	-190.5	16,000	15,600	0.437	215.4
180	201	342.5	-212.5	16,000	16,300	0.426	232.1
181	182	290.0	-230.5	15,900	16,400	0.198	100.0
181	200	325.0	-145.5	16,100	16,100	0.325	152.9
182	183	290.0	-340.0	15,900	16,500	0.639	387.9
182	199	326.0	-284.0	16,300	16,100	0.605	373.8
183	184	290.0	-242.5	15,700	16,100	0.482	250.3
183	198	321.0	-249.0	16,300	15,900	0.583	340.6
184	185	286.5	-136.0	16,000	16,300	0.538	223.1
184	197	300.0	-122.5	16,200	15,800	0.162	70.0
185	186	284.5	-143.0	16,000	16,100	0.165	70.0
185	196	284.0	-116.0	16,400	15,800	0.241	100.0
186	187	308.0	-113.5	16,100	17,000	0.538	214.8
186	195	325.5	-112.0	15,900	17,500	0.504	200.5
187	188	371.0	-68.0	5,500	21,700	0.359	40.0
187	193	382.5	-61.5	6,000	19,700	0.148	20.0
187	194	360.0	-62.5	15,800	15,200	0.673	295.4
187	195	347.5	-76.5	1,400	24,000	0.538	13.3
188	189	440.0	100.0	13,200	17,700	0.789	200.0
188	191	491.0	-94.0	15,800	21,100	0.068	30.0
188	193	423.5	-51.5	17,900	14,100	0.166	100.0
189	191	487.5	-115.0	3,000	23,300	0.129	10.0
191	192	565.0	-294.0	14,600	16,500	0.001	1.0
191	211	612.5	-217.5	3,700	20,200	0.000	0.0
192	193	500.0	10.0	16,400	16,700	0.002	1.0

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Perme- ability	Conduc- tivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ ft^2-yr)
192	210	605.0	-704.0	9,800	17,000	0.212	160.0
192	211	607.5	-381.5	17,400	11,600	0.115	170.0
193	194	412.5	-46.0	13,600	14,500	0.233	100.0
193	209	457.5	-17.5	8,300	18,900	1.198	250.0
193	210	530.0	10.0	1,900	24,900	0.006	0.2
194	195	377.5	-61.0	12,300	16,800	0.628	201.5
194	209	435.0	-18.5	15,000	11,000	0.485	300.0
195	196	325.0	-85.0	16,000	17,100	0.415	159.1
195	207	365.0	-155.0	3,500	22,200	0.381	31.2
195	208	432.5	-37.5	14,000	16,400	0.560	224.9
195	209	422.5	-32.5	3,100	19,300	0.516	37.7
196	197	297.5	-102.5	14,900	16,100	0.135	50.0
196	207	325.0	-165.0	16,300	15,100	0.291	154.2
197	198	331.0	-129.0	16,000	16,400	0.223	100.0
197	206	385.0	-150.0	15,700	16,400	0.359	183.7
197	207	337.5	-172.5	1,500	21,400	0.291	10.4
198	199	357.0	-193.0	16,100	16,300	0.549	298.4
198	205	423.5	-136.5	16,300	16,400	0.729	405.5
199	200	361.0	-199.0	16,300	16,400	0.180	100.0
199	204	441.0	-181.5	16,300	16,100	0.762	480.4
200	201	377.5	-167.5	16,400	15,800	0.314	177.6
200	203	442.5	-62.5	16,300	16,100	0.587	300.0
201	202	490.0	-20.0	15,900	15,800	0.247	126.6
202	203	555.0	85.0	18,000	16,000	0.189	100.0
202	220	780.0	100.0	15,800	19,900	0.257	139.0
203	204	522.5	-45.0	17,800	16,300	0.242	150.0
203	219	750.0	30.0	16,000	20,400	0.650	367.0
204	205	507.5	-125.0	17,900	16,100	0.942	662.2
204	218	730.0	-80.0	16,200	20,600	0.659	420.0
205	206	477.5	-157.5	17,900	16,400	0.289	200.0
205	217	673.0	-100.0	16,700	19,900	0.651	422.0
206	207	412.5	-212.5	17,900	15,700	0.140	100.0
206	216	580.0	-160.0	16,600	17,800	0.527	364.0
207	208	432.5	-117.5	3,900	20,700	0.437	45.3
207	215	397.5	-187.5	20,800	10,300	0.336	397.3
208	209	490.0	5.0	15,500	16,000	0.583	274.0
208	214	780.0	270.0	17,100	17,900	0.103	50.0
208	215	465.0	-70.0	16,900	16,200	0.516	287.8
209	210	565.0	110.0	16,500	17,400	0.006	2.4
209	214	620.0	190.0	2,700	23,800	0.006	0.3
210	211	652.5	-627.5	8,400	19,700	0.128	70.0
210	212	691.0	-601.0	1,800	19,700	0.059	7.0

TABLE 35 (continued)

UNCONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Perme-ability	Conduc-tivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
210	213	720.0	-780.0	17,100	11,400	0.111	250.0
210	214	705.0	-696.0	15,000	21,500	0.235	230.0
211	212	693.5	-278.5	16,200	13,900	0.040	45.0
212	213	761.0	-431.0	18,700	16,900	0.083	110.0
213	214	775.0	-526.0	16,700	18,300	0.253	300.0
215	216	565.0	-140.0	12,900	22,200	0.244	100.0
216	217	775.0	-105.0	19,700	17,300	0.439	440.0
217	218	895.0	-65.0	21,300	16,900	0.397	480.0
218	219	957.5	-20.0	21,200	16,200	0.117	150.0
219	220	975.0	30.0	20,400	16,000	0.315	380.0

1/ Dummy nodes.

TABLE 36

CONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between: Node No.	Path Between: Node No.	Flow Path Dimensions: Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	Permeability (af/ft²-yr)	Conductivity (af-ft/ft²-yr)
301	302	-755.0	-1,215.0	15,900	15,900	0.224	103.1
301	521[1/]	-753.5	-1,163.5	16,000	16,200	0.336	136.1
302	303	-769.0	-1,269.0	15,800	15,900	0.224	111.4
302	329	-654.0	-1,184.0	16,200	15,800	0.213	115.7
302	522[1/]	-901.5	-1,351.5	16,100	16,400	0.224	99.0
303	304	-568.5	-1,078.5	15,900	16,400	0.247	121.9
303	328	-640.0	-1,130.0	16,100	16,300	0.168	81.4
303	523[1/]	-802.5	-1,252.5	16,300	16,300	0.141	63.5
304	305	-392.0	-952.0	16,400	16,500	0.191	106.1
304	327	-376.5	-896.5	16,300	15,800	0.112	60.0
304	524[1/]	-541.0	-1,011.0	16,300	16,400	0.224	104.6
305	306	-257.5	-857.5	16,100	16,000	0.112	67.7
305	326	-303.5	-853.5	16,500	16,200	0.392	219.8
305	525[1/]	-396.0	-896.0	16,700	16,300	0.134	68.6
306	307	-159.0	-829.0	16,100	16,200	0.120	80.0
306	325	-170.5	-810.5	16,400	16,000	0.448	294.1
306	526[1/]	-286.5	-786.5	16,200	16,300	0.112	55.7
307	308	-109.5	-929.5	16,600	15,700	0.269	233.3
307	324	-117.5	-907.5	15,900	16,000	0.359	281.6
307	527[1/]	-187.5	-857.5	15,900	16,600	0.390	250.0
308	309	-101.0	-1,131.0	16,000	16,200	0.202	205.3
308	323	-93.5	-1,063.5	16,000	15,900	0.179	175.1
308	528[1/]	-142.0	-967.0	15,900	16,400	0.313	250.0
309	310	-132.5	-1,422.5	16,100	16,000	0.154	200.0
309	322	-108.0	-1,248.0	16,400	16,000	0.086	100.0
309	529[1/]	-209.0	-1,239.0	16,300	15,600	0.186	200.0
310	311	-116.0	-1,606.0	16,100	16,400	0.137	200.0
310	321	-119.5	-1,499.5	16,400	16,200	0.143	200.0
310	530[1/]	-198.5	-1,518.5	16,300	16,100	0.224	300.0
311	312	-52.5	-1,522.5	16,000	16,600	0.141	200.0
311	320	-74.0	-1,584.0	15,900	16,000	0.359	538.3
311	531[1/]	-117.5	-1,567.5	15,800	16,000	0.210	300.0
312	313	29.0	-1,221.0	15,800	15,600	0.224	283.8
312	319	-21.5	-1,451.5	16,300	16,300	0.247	352.7
312	532[1/]	-80.0	-1,360.0	16,200	15,500	0.168	224.8
313	318	72.5	-1,087.5	16,100	16,100	0.086	100.0
313	533[1/]	44.0	-1,026.0	16,100	16,100	0.280	300.0
318	319	22.0	-1,318.0	16,100	16,100	0.149	200.0
318	340	81.0	-1,069.0	16,000	15,800	0.112	130.5
319	320	-43.0	-1,513.0	16,100	16,200	0.258	376.7
319	339	-6.0	-1,506.0	16,400	16,000	0.130	200.0
320	321	-77.5	-1,477.5	16,000	16,100	0.144	200.0
320	338	-52.5	-1,502.5	16,000	15,900	0.445	650.0

TABLE 36 (continued)

CONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Perme-ability	Conduc-tivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft²-yr)	(af-ft/ft²-yr)
321	322	-95.0	-1,325.0	16,500	16,400	0.404	499.4
321	337	-81.0	-1,321.0	16,300	16,000	0.158	200.0
322	323	-100.5	-1,180.5	16,100	16,000	0.269	292.4
322	336	-94.0	-1,154.0	16,400	16,100	0.093	100.0
323	324	-101.5	-1,041.5	16,100	15,800	0.280	268.4
323	335	-111.5	-1,001.5	16,100	16,200	0.113	100.0
324	325	-129.0	-889.0	16,100	16,200	0.605	457.2
324	334	-115.0	-835.0	16,000	16,200	0.527	374.7
325	326	-216.5	-806.5	16,100	16,300	0.429	250.0
325	333	-145.5	-735.5	16,300	16,500	0.650	378.9
326	327	-288.0	-798.0	16,000	16,300	0.140	70.0
326	332	-191.5	-721.5	16,400	16,400	0.189	100.0
327	328	-448.0	-948.0	16,100	16,300	0.280	138.4
327	331	-335.0	-865.0	16,300	16,400	0.504	265.7
328	329	-525.0	-1,045.0	16,100	15,900	0.269	141.7
328	330	-491.5	-961.5	16,200	16,100	0.235	111.3
329	330	-421.5	-931.5	5,100	22,800	0.269	30.7
330	331	-378.5	-878.5	16,200	16,100	0.392	197.4
330	354	-380.0	-810.0	8,500	22,600	0.280	45.3
331	332	-238.5	-788.5	16,400	16,400	0.182	100.0
331	354	-370.5	-840.5	16,100	15,500	0.448	218.9
332	333	-120.5	-650.5	16,300	16,200	0.188	100.0
332	353	-149.0	-629.0	16,400	15,800	0.437	217.8
333	334	-131.5	-681.5	16,400	16,400	0.572	314.4
333	352	-116.5	-576.5	16,300	16,000	0.504	236.4
334	335	-125.0	-795.0	16,400	16,000	0.218	150.0
334	351	-135.0	-675.0	16,100	16,500	0.572	301.2
335	336	-105.0	-975.0	16,100	16,000	0.482	422.0
335	350	-136.0	-806.0	15,900	16,400	0.493	320.4
336	337	-80.0	-1,150.0	16,300	16,300	0.654	700.0
336	349	-101.0	-1,081.0	16,300	16,400	0.616	600.0
337	338	-56.0	-1,346.0	16,100	16,200	0.624	800.0
337	348	-61.0	-1,181.0	16,400	16,000	0.653	750.0
338	339	-15.5	-1,495.5	15,900	16,000	0.136	200.0
338	347	-9.5	-1,329.5	16,200	16,200	0.650	858.2
339	340	53.0	-1,257.0	15,900	16,500	0.179	226.4
339	346	22.5	-1,417.5	16,400	16,100	0.404	591.9
346	347	28.5	-1,251.5	16,400	15,900	0.227	300.0
346	363	61.0	-1,289.0	16,300	16,100	0.219	300.0
347	348	-14.5	-1,164.5	16,300	16,100	0.549	639.5
347	362	31.5	-1,138.5	16,100	16,100	0.426	498.4
348	349	-82.0	-1,112.0	16,400	16,400	0.194	200.0
348	361	-30.5	-1,120.5	16,300	16,200	0.504	553.2

TABLE 36 (continued)

CONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Perme-ability	Conduc-tivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft²-yr)	(af-ft/ft²-yr)
349	350	-132.0	-912.0	16,100	16,000	0.637	500.0
349	360	-85.0	-995.0	16,300	16,200	0.605	554.2
350	351	-146.0	-686.0	16,000	15,800	0.183	100.0
350	359	-116.5	-716.5	15,800	16,000	0.624	370.0
351	352	-120.0	-570.0	16,000	15,800	0.219	100.0
351	358	-110.5	-600.5	16,100	15,900	0.202	100.0
352	353	-145.0	-555.0	15,800	16,200	0.175	70.0
352	357	-165.0	-575.0	16,200	16,300	0.617	251.2
353	354	-281.0	-681.0	15,900	16,400	0.181	70.0
353	356	-227.5	-627.5	16,400	16,500	0.176	70.0
354	355	-283.5	-683.5	15,900	16,500	0.381	146.9
355	356	-230.0	-630.0	16,600	16,300	0.482	196.4
355	378	-160.0	-530.0	16,000	16,300	0.325	118.1
356	357	-247.5	-647.5	16,600	16,200	0.146	60.0
356	377	-245.0	-665.0	16,500	16,200	0.234	100.0
357	358	-155.5	-605.5	16,100	16,300	0.225	100.0
357	376	-240.0	-660.0	16,300	16,000	0.234	100.0
358	359	-81.0	-631.0	16,500	15,900	0.263	150.0
358	375	-146.5	-576.5	16,100	16,200	0.234	100.0
359	360	-69.5	-799.5	16,300	16,300	0.342	250.0
359	374	-59.5	-559.5	15,800	15,900	0.706	350.9
360	361	-33.5	-1,003.5	16,100	16,100	0.206	200.0
360	373	-59.0	-839.0	16,400	16,200	0.405	320.0
361	362	15.5	-1,094.5	16,000	16,400	0.381	412.7
361	372	-55.0	-1,065.0	16,300	16,200	0.560	569.6
362	363	64.0	-1,176.0	16,200	16,000	0.471	591.1
362	371	-7.5	-1,097.5	16,300	16,200	0.410	450.0
363	370	56.5	-1,223.5	16,500	16,300	0.437	566.5
370	371	-15.0	-1,145.0	16,100	16,300	0.538	600.0
370	386	-28.0	-1,138.0	16,400	16,100	0.291	329.5
371	372	-78.0	-1,068.0	15,900	16,500	0.210	200.0
371	385	-85.0	-975.0	16,300	16,200	0.673	602.3
372	373	-80.5	-900.5	15,900	15,900	0.244	200.0
372	384	-119.5	-789.5	16,300	16,100	0.295	200.0
373	374	-49.0	-599.0	15,700	16,300	0.189	100.0
373	383	-102.5	-632.5	16,400	15,900	0.594	324.8
374	375	-125.0	-505.0	15,800	15,900	0.265	100.0
374	382	-126.0	-586.0	15,800	16,000	0.605	275.0
375	376	-231.0	-631.0	15,900	16,400	0.181	70.0
375	381	-185.0	-535.0	16,200	15,600	0.413	150.0
376	377	-237.5	-677.5	15,900	16,100	0.092	40.0
376	380	-221.5	-661.5	16,300	15,800	0.176	80.0
377	378	-175.0	-565.0	15,800	16,200	0.318	145.0
377	379	-227.5	-647.5	16,400	16,000	0.465	200.0

TABLE 36 (continued)

CONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Perme-ability	Conduc-tivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
379	380	-211.5	-631.5	15,800	16,100	0.347	143.2
379	402	-210.0	-590.0	16,000	16,000	0.303	115.0
380	381	-175.5	-565.5	16,000	16,100	0.181	70.0
380	401	-208.0	-638.0	16,300	16,400	0.448	191.6
381	382	-186.0	-616.0	15,900	16,000	0.234	100.0
381	400	-165.5	-565.5	16,000	16,400	0.128	50.0
382	383	-179.5	-619.5	16,000	16,000	0.523	230.0
382	399	-197.0	-607.0	16,000	15,900	0.639	263.6
383	384	-141.5	-521.5	16,000	16,100	0.796	300.6
383	398	-176.5	-616.5	16,100	15,900	0.785	349.6
384	385	-126.5	-696.5	16,300	16,600	0.268	150.0
384	397	-138.0	-548.0	16,400	16,100	0.897	374.5
385	386	-98.0	-968.0	16,100	16,200	0.504	436.1
385	396	-98.5	-818.5	16,000	16,100	0.617	441.1
386	387	-40.5	-1,259.5	16,200	16,300	0.397	480.7
386	395	-96.5	-1,076.5	16,400	16,300	0.381	375.8
387	394	-50.0	-1,517.0	16,100	16,400	0.487	701.8
393	394	-48.5	-2,059.0	16,600	16,200	0.170	350.0
393	411	-17.5	-2,530.0	16,300	16,400	0.020	50.0
394	395	-106.0	-1,334.0	16,300	16,000	0.240	300.0
394	410	-115.0	-1,729.5	15,900	15,800	0.031	50.0
395	396	-97.0	-927.0	16,100	16,200	0.303	250.0
395	409	-122.0	-1,022.0	16,400	15,800	0.107	100.0
396	397	-110.0	-670.0	15,800	16,100	0.182	100.0
396	408	-116.0	-736.0	15,700	15,900	0.163	100.0
397	398	-173.0	-643.0	15,700	16,200	0.886	403.4
397	407	-150.5	-580.5	16,400	15,800	0.224	100.0
398	399	-194.0	-604.0	15,800	16,100	0.796	320.2
398	406	-159.5	-639.5	16,000	15,900	0.725	350.0
399	400	-176.5	-556.5	16,100	16,200	0.132	50.0
399	405	-179.5	-579.5	16,300	16,100	0.247	100.0
400	401	-198.0	-638.0	16,300	15,700	0.628	286.8
400	404	-185.0	-705.0	15,800	16,000	0.682	350.0
401	402	-206.5	-596.5	16,400	16,300	0.404	158.3
401	403	-231.5	-711.5	16,200	15,800	0.740	364.1
403	404	-218.5	-778.5	15,900	16,300	0.549	300.0
404	405	-188.0	-728.0	16,100	16,100	0.370	200.0
404	431	-178.5	-828.5	15,900	15,900	0.615	400.0
405	406	-145.0	-615.0	16,400	16,200	0.420	200.0
405	430	-187.0	-717.0	16,200	16,300	0.095	50.0
406	407	-137.0	-577.0	16,600	16,500	0.226	100.0
406	429	-142.0	-612.0	16,600	16,300	0.104	50.0
407	408	-156.5	-646.5	16,500	16,300	0.302	150.0

TABLE 36 (continued)

CONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Perme-ability	Conduc-tivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
407	428	-131.0	-621.0	16,400	16,600	0.083	40.0
408	409	-141.0	-831.0	16,300	16,300	0.145	100.0
408	427	-133.5	-833.5	16,100	16,400	0.146	100.0
409	410	-131.0	-1,417.5	16,300	16,400	0.039	50.0
409	426	-133.0	-933.0	16,600	16,400	0.123	100.0
410	411	-84.0	-2,200.5	16,200	16,100	0.047	100.0
410	425	-130.0	-1,756.5	16,100	16,200	0.049	80.0
411	412	31.0	-2,719.0	16,300	16,500	0.037	100.0
411	424	-74.0	-2,289.0	16,500	15,800	0.030	70.0
412	423	65.0	-2,960.0	16,200	15,800	0.032	100.0
422	423	80.0	-3,010.0	16,300	16,300	0.291	900.0
422	440	39.0	-3,311.0	16,500	16,500	0.239	800.0
423	424	-40.0	-2,530.0	16,200	16,300	0.121	300.0
423	439	-40.0	-3,275.0	16,200	16,100	0.184	600.0
424	425	-120.0	-1,845.0	16,200	16,400	0.041	70.0
424	438	-82.0	-1,987.0	16,500	16,200	0.258	500.0
425	426	-132.0	-1,272.0	16,200	16,600	0.045	50.0
425	437	-111.5	-1,451.5	16,200	16,200	0.149	200.0
426	427	-125.5	-935.5	16,300	16,200	0.245	200.0
426	436	-132.0	-932.0	16,600	16,300	0.061	50.0
427	428	-108.0	-808.0	16,300	16,200	0.142	100.0
427	435	-157.5	-857.5	16,300	16,200	0.028	20.0
428	429	-136.0	-656.0	16,300	16,300	0.192	100.0
428	434	-139.5	-579.5	16,200	16,400	0.092	40.0
429	430	-184.0	-714.0	16,200	16,300	0.114	60.0
429	433	-191.5	-591.5	16,300	16,100	0.148	60.0
430	431	-177.5	-817.5	16,400	16,200	0.807	522.9
430	432	-182.5	-577.5	16,100	16,000	0.252	100.0
432	433	-190.0	-455.0	16,400	16,100	0.211	57.0
433	434	-195.0	-515.0	16,200	16,200	0.250	80.0
433	458	-165.0	-480.0	7,200	22,500	0.289	100.0
434	435	-189.0	-629.0	16,100	16,200	0.229	100.0
434	458	-150.0	-485.0	16,300	15,800	0.223	70.0
435	436	-164.0	-854.0	16,100	16,400	0.221	150.0
435	457	-174.0	-814.0	16,200	16,400	0.237	150.0
436	437	-111.5	-1,111.5	16,200	16,500	0.204	200.0
436	456	-128.0	-1,128.0	16,600	16,300	0.196	200.0
437	438	-73.5	-1,593.5	16,300	16,500	0.200	300.0
437	455	-134.5	-1,464.5	16,200	16,700	0.233	300.0
438	439	-82.0	-2,732.0	16,400	16,300	0.263	700.0
438	454	-113.0	-2,273.0	16,500	16,300	0.274	600.0
439	440	-81.0	-3,576.0	16,300	16,400	0.259	900.0
439	453	-104.0	-3,314.0	16,200	16,600	0.223	700.0

TABLE 36 (continued)

CONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft^2-yr)	(af-ft/ft^2-yr)
440	441	-17.0	-2,672.0	16,300	16,400	0.152	400.0
440	452	-80.0	-3,535.0	16,500	16,200	0.227	800.0
441	451	-51.5	-1,981.5	16,200	16,300	0.209	400.0
450	451	-78.0	-1,888.0	16,600	16,000	0.213	400.0
450	466	-39.0	-1,739.0	16,400	16,000	0.287	500.0
451	452	-114.5	-2,844.5	16,600	16,300	0.252	700.0
451	465	-89.5	-2,429.5	16,100	16,200	0.258	600.0
452	453	-103.0	-3,273.0	16,600	16,300	0.310	1,000.0
452	464	-115.0	-3,205.0	16,600	16,400	0.320	1,000.0
453	454	-135.0	-2,855.0	16,500	16,500	0.257	700.0
453	463	-153.5	-2,733.5	16,300	16,400	0.390	1,000.0
454	455	-174.0	-2,144.0	16,600	16,500	0.252	500.0
454	462	-222.0	-2,342.0	16,300	16,400	0.285	600.0
455	456	-151.0	-1,481.0	16,700	16,200	0.219	300.0
455	461	-239.5	-1,679.5	16,400	16,300	0.276	400.0
456	457	-138.0	-1,088.0	16,500	16,200	0.207	200.0
456	460	-237.0	-1,117.0	16,600	16,400	0.225	200.0
457	458	-135.0	-670.0	16,400	16,000	0.109	60.0
457	459	-175.0	-745.0	16,100	16,500	0.180	100.0
459	460	-274.0	-774.0	16,300	16,000	0.196	100.0
459	478	-270.0	-800.0	16,200	16,100	0.280	149.5
460	461	-325.5	-1,315.5	16,200	16,400	0.205	200.0
460	477	-329.5	-1,029.5	16,300	16,200	0.213	150.0
461	462	-287.5	-1,877.5	16,100	16,700	0.261	400.0
461	476	-301.5	-1,741.5	16,500	16,300	0.137	200.0
462	463	-240.5	-2,220.5	16,300	16,400	0.254	500.0
462	475	-266.0	-1,816.0	16,300	16,100	0.255	400.0
463	464	-165.5	-2,665.5	16,100	16,400	0.367	900.0
463	474	-206.0	-1,936.0	16,300	16,300	0.231	400.0
464	465	-90.0	-2,790.0	16,000	16,400	0.228	600.0
464	473	-146.5	-2,326.5	16,500	16,500	0.275	600.0
465	466	-50.5	-2,280.5	16,100	16,100	0.224	500.0
465	472	-76.5	-2,256.5	16,100	16,000	0.274	600.0
466	467	16.5	-1,703.5	16,200	16,700	0.120	200.0
466	471	-24.0	-1,704.0	16,400	16,300	0.296	500.0
467	470	-7.5	-1,387.5	16,800	16,000	0.207	300.0
469	470	-53.0	-1,263.0	15,900	15,400	0.296	370.0
469	488	-46.5	-1,296.5	2,800	20,700	0.336	56.9
469	489	-71.0	-1,205.0	16,000	11,300	0.249	400.0
470	471	-48.0	-1,388.0	16,000	15,900	0.111	150.0
470	487	-109.5	-1,269.5	7,300	22,200	0.262	100.0
470	488	-84.5	-1,344.5	13,000	18,400	0.225	200.0

TABLE 36 (continued)

CONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Permeability	Conductivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft²-yr)	(af-ft/ft²-yr)
471	472	-50.0	-1,680.0	16,100	16,000	0.274	450.0
471	487	-66.5	-1,346.5	16,400	16,200	0.077	100.0
472	473	-133.0	-1,793.0	16,000	16,100	0.242	400.0
472	486	-149.5	-1,549.5	16,000	16,500	0.059	80.0
473	474	-187.0	-1,597.0	16,400	16,500	0.214	300.0
473	485	-189.0	-1,499.0	16,400	15,900	0.148	200.0
474	475	-231.5	-1,531.5	16,400	16,100	0.227	300.0
474	484	-206.5	-1,456.5	16,200	16,200	0.160	200.0
475	476	-280.0	-1,680.0	16,400	16,500	0.144	200.0
475	483	-320.0	-1,530.0	16,400	16,300	0.246	300.0
476	477	-305.5	-1,455.5	16,200	16,100	0.130	150.0
476	482	-337.5	-1,557.5	16,300	16,100	0.162	200.0
477	478	-325.5	-1,055.5	16,400	15,800	0.235	178.4
477	481	-285.5	-1,155.5	16,000	16,200	0.233	200.0
478	479	-292.5	-892.5	16,500	17,800	0.090	49.9
478	480	-325.0	-1,015.0	16,400	16,200	0.429	300.0
480	481	-285.0	-1,115.0	16,000	15,600	0.235	200.0
480	501	-262.5	-972.5	16,000	16,300	0.287	200.0
481	482	-317.5	-1,257.5	15,900	16,400	0.384	350.0
481	500	-270.0	-1,110.0	16,100	16,100	0.179	150.0
482	483	-377.5	-1,407.5	15,900	16,500	0.101	100.0
482	499	-330.5	-1,220.5	16,300	16,100	0.166	150.0
483	484	-295.0	-1,455.0	15,700	16,100	0.177	200.0
483	498	-304.0	-1,474.0	16,300	15,900	0.067	80.0
484	485	-208.5	-1,358.5	16,000	16,300	0.115	130.0
484	497	-224.0	-1,304.0	16,200	15,800	0.036	40.0
485	486	-205.5	-1,255.5	16,000	16,100	0.347	362.6
485	496	-206.0	-1,386.0	16,400	15,800	0.033	40.0
486	487	-166.0	-1,216.0	16,100	17,000	0.201	200.0
486	495	-194.5	-1,664.5	15,900	17,500	0.030	40.0
487	488	-103.0	-1,303.0	5,500	21,700	0.164	50.0
487	493	-105.0	-1,495.0	6,000	19,700	0.118	50.0
487	494	-133.0	-1,373.0	15,800	15,200	0.078	100.0
487	495	-156.5	-1,676.5	1,400	24,000	0.056	5.0
488	489	-102.5	-1,286.5	13,200	17,700	0.227	200.0
488	493	-80.0	-1,570.0	17,900	14,100	0.159	300.0
493	494	-110.0	-1,640.0	13,600	14,500	0.209	300.0
493	509	-56.0	-2,196.0	8,300	18,900	0.213	200.0
494	495	-161.5	-1,821.5	12,300	16,800	0.165	200.0
494	509	-84.0	-2,074.0	15,000	11,000	0.029	80.0
495	496	-195.0	-1,795.0	16,000	17,100	0.134	200.0
495	507	-245.0	-1,755.0	3,500	22,200	0.042	10.0

TABLE 36 (continued)

CONFINED LAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Perme- ability	Conduc- tivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft²-yr)	(af-ft/ft²-yr)
495	508	-107.5	-2,067.5	14,000	16,400	0.042	70.0
495	509	-107.5	-2,377.5	3,100	19,300	0.027	10.0
496	497	-221.5	-1,331.5	14,900	16,100	0.146	150.0
496	507	-255.0	-1,425.0	16,300	15,100	0.055	70.0
497	498	-233.0	-1,323.0	16,000	16,400	0.047	50.0
497	506	-224.0	-1,274.0	15,700	16,400	0.070	70.0
497	507	-271.5	-1,291.5	1,500	21,400	0.042	3.0
498	499	-257.0	-1,287.0	16,100	16,300	0.147	150.0
498	505	-191.5	-1,531.5	16,300	16,400	0.053	70.0
499	500	-283.0	-1,073.0	16,300	16,400	0.213	167.2
499	504	-220.5	-1,360.5	16,300	16,100	0.061	70.0
500	501	-247.5	-967.5	16,400	15,800	0.201	150.0
500	503	-172.5	-1,002.5	16,300	16,100	0.238	200.0
501	502	-95.0	-665.0	15,900	15,800	0.349	200.0
502	503	-20.0	-700.0	18,000	16,000	0.327	250.0
502	520	2.5	-707.5	15,800	19,900	0.259	146.0
503	504	-110.0	-1,290.0	17,800	16,300	0.078	100.0
503	519	-62.5	-1,102.5	16,000	20,400	0.319	260.0
504	505	-155.0	-1,605.0	17,900	16,100	0.062	100.0
504	518	-132.5	-1,527.5	16,200	20,600	0.383	420.0
505	506	-182.5	-1,482.5	17,900	16,400	0.317	450.0
505	517	-142.5	-1,987.5	16,700	19,900	0.323	500.0
506	507	-257.5	-1,367.5	17,900	15,700	0.356	450.0
506	516	-190.0	-2,175.0	16,600	17,800	0.270	500.0
507	508	-167.5	-1,697.5	3,900	20,700	0.173	50.0
507	515	-242.5	-1,582.5	20,800	10,300	0.222	600.0
508	509	-30.0	-2,320.0	15,500	16,000	0.036	80.0
508	515	-105.0	-1,895.0	16,900	16,200	0.268	500.0
515	516	-175.0	-2,390.0	12,900	22,200	0.389	500.0
516	517	-150.0	-2,680.0	19,700	17,300	0.208	600.0
517	518	-120.0	-1,910.0	21,300	16,900	0.067	150.0
518	519	-85.0	-1,340.0	21,200	16,200	0.061	100.0
519	520	-40.0	-1,110.0	20,400	16,000	0.220	300.0

1/ Dummy nodes.

TABLE 37

INTERLAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between Node No.	Path Between Node No.	Clay Thickness (feet)	Conductivity (af-ft/ ft^2-yr)
1	301	55	10.0
2	302	100	5.0
3	303	125	6.0
4	304	90	6.0
5	305	100	8.0
6	306	100	10.0
7	307	50	30.0
8	308	60	10.0
9	309	145	5.0
10	310	90	1.0
11	311	34	1.0
12	312	110	1.0
13	313	20	1.0
18	318	35	1.0
19	319	50	30.0
20	320	65	10.0
21	321	65	10.0
22	322	65	5.0
23	323	50	75.0
24	324	79	40.0
25	325	50	10.0
26	326	60	9.0
27	327	100	3.0
28	328	180	1.0
29	329	220	5.0
30	330	150	1.0
31	331	125	1.0
32	332	120	1.0
33	333	96	15.0
34	334	95	30.0
35	335	95	5.0
36	336	89	25.0
37	337	87	50.0
38	338	52	10.0
39	339	32	20.0
40	340	30	30.0
46	346	38	50.0
47	347	20	70.0
48	348	25	20.0
49	349	70	60.0
50	350	35	100.0
51	351	43	10.0
52	352	160	3.0
53	353	105	1.0
54	354	120	1.0
55	355	60	1.0
56	356	35	10.0
57	357	15	30.0
58	358	29	10.0
59	359	30	10.0
60	360	60	70.0
61	361	44	90.0
62	362	20	80.0
63	363	24	100.0
70	370	35	60.0
71	371	70	5.0
72	372	40	150.0
73	373	11	7.0
74	374	20	1.0
75	375	61	1.0
76	376	50	1.0
77	377	40	2.0
78	378	25	1.0
79	379	40	12.0
80	380	44	2.0
81	381	30	7.0
82	382	28	1.0
83	383	50	40.0
84	384	31	250.0
85	385	47	240.0
86	386	44	270.0
87	387	40	75.0
93	393	75	10.0
94	394	60	243.0
95	395	56	143.0
96	396	81	30.0
97	397	33	149.0
98	398	28	1.0
99	399	24	1.0
100	400	24	1.0
101	401	30	54.0
102	402	70	1.0
103	403	45	10.0
104	404	50	5.0
105	405	18	1.0
106	406	35	200.0

TABLE 37 (continued)

INTERLAYER NODE-TO-NODE FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between Node No.	Node No.	Clay Thickness (feet)	Conductivity (af-ft/ft²-yr)	Path Between Node No.	Node No.	Clay Thickness (feet)	Conductivity (af-ft/ft²-yr)
107	407	40	130.0	169	469	50	1.0
108	408	38	200.0	170	470	25	10.0
109	409	24	100.0	171	471	55	1.0
110	410	26	5.0	172	472	40	1.0
111	411	100	100.0	173	473	138	5.0
112	412	50	40.0	174	474	31	30.0
122	422	50	1.0	175	475	45	30.0
123	423	100	200.0	176	476	40	2.0
124	424	110	50.0	177	477	35	10.0
125	425	10	50.0	178	478	80	1.0
126	426	97	100.0	179	479	95	1.0
127	427	41	110.0	180	480	60	1.0
128	428	30	110.0	181	481	129	1.0
129	429	75	4.0	182	482	45	1.0
130	430	40	5.0	183	483	30	80.0
131	431	30	60.0	184	484	75	90.0
132	432	30	2.0	185	485	70	20.0
133	433	20	54.0	186	486	55	1.0
134	434	90	200.0	187	487	50	10.0
135	435	20	220.0	188	488	20	30.0
136	436	30	170.0	189	489	27	20.0
137	437	24	5.0	193	493	37	1.0
138	438	25	30.0	194	494	91	60.0
139	439	50	50.0	195	495	110	10.0
140	440	30	150.0	196	496	110	30.0
141	441	125	120.0	197	497	128	8.0
150	450	23	40.0	198	498	80	14.0
151	451	40	40.0	199	499	48	4.0
152	452	30	150.0	200	500	120	1.0
153	453	50	100.0	201	501	40	1.0
154	454	95	50.0	202	502	110	1.0
155	455	98	10.0	203	503	100	2.0
156	456	50	70.0	204	504	30	10.0
157	457	70	30.0	205	505	30	10.0
158	458	60	15.0	206	506	20	10.0
159	459	65	51.0	207	507	70	1.0
160	460	65	1.0	208	508	30	2.0
161	461	35	1.0	209	509	40	3.0
162	462	45	80.0	215	515	40	1.0
163	463	15	70.0	216	516	40	1.0
164	464	19	150.0	217	517	50	1.0
165	465	30	115.0	218	518	60	1.0
166	466	29	1.0	219	519	50	1.0
167	467	30	1.0	220	520	30	3.0

TABLE 38

FOREBAY NODES TO CONFINED AQUIFER NODES
FLOW PATH DATA
DATA BASE FOR RUN 'A'
May 30, 1974

Path Between		Flow Path Dimensions				Perme-ability	Conduc-tivity
Node No.	Node No.	Top (feet)	Bottom (feet)	Width (feet)	Length (feet)	(af/ft²-yr)	(af-ft/ft²-yr)
14	313	120.0	-800.0	15,800	15,900	0.109	100.0
17	318	120.0	-800.0	16,300	16,300	0.272	250.0
41	340	120.0	-850.0	15,900	16,200	0.105	100.0
45	340	140.0	-1,050.0	16,100	15,900	0.083	100.0
45	346	120.0	-1,300.0	16,200	16,500	0.215	300.0
64	363	130.0	-1,200.0	16,100	16,500	0.462	600.0
69	370	50.0	-1,500.0	16,100	16,400	0.394	600.0
69	387	80.0	-1,600.0	16,300	16,000	0.370	633.1
88	387	90.0	-1,700.0	16,100	16,200	0.343	609.6
88	393	100.0	-2,200.0	16,400	16,400	0.307	706.2
92	393	140.0	-2,500.0	16,600	16,100	0.147	400.0
92	412	180.0	-2,600.0	16,000	16,400	0.002	5.0
113	412	180.0	-2,500.0	16,100	16,000	0.037	100.0
113	422	180.0	-2,600.0	16,500	16,200	0.035	100.0
121	422	170.0	-2,000.0	16,500	16,400	0.595	1,300.0
121	441	190.0	-1,700.0	16,200	16,300	0.266	500.0
142	441	200.0	-1,150.0	16,300	15,900	0.506	700.0
142	450	140.0	-900.0	12,300	16,300	0.255	200.0
143	450	100.0	-900.0	4,700	18,100	0.083	20.0
148	467	140.0	-1,200.0	16,500	17,200	0.389	500.0
148	469	60.0	-650.0	14,600	15,500	0.523	350.0
149	450	70.0	-1,300.0	14,000	18,400	0.096	100.0
149	467	130.0	-1,300.0	16,800	14,600	0.304	500.0
168	469	80.0	-1,000.0	18,500	17,200	0.129	150.0
168	489	-110.0	-1,005.5	10,900	16,100	0.247	150.0
191	488	246.0	-754.0	15,800	21,100	0.000	0.0
191	489 1/						
192	493	-80.0	-1,000.0	16,400	16,700	0.006	5.1
210	493	-50.0	-1,000.0	1,900	24,900	0.006	0.4
210	509	70.0	-1,800.0	16,500	17,400	0.003	6.0
214	508	230.0	-1,100.0	17,100	17,900	0.002	3.0
214	509	150.0	-1,500.0	2,700	23,800	0.006	1.0

1/ Link between nodes 191 and 489 not activated.

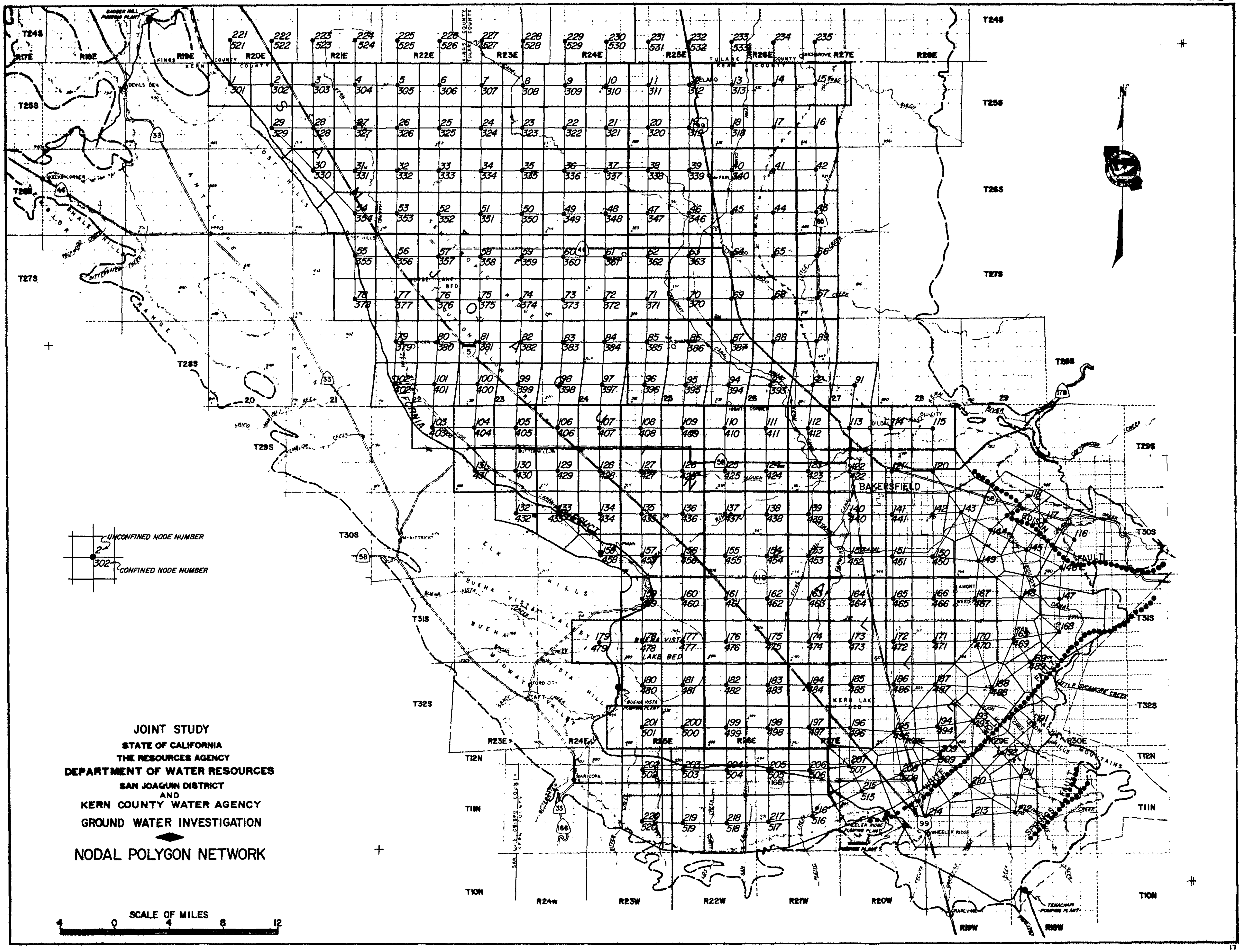
TABLE 39

SPECIFIC YIELD VALUES USED
IN MODEL STUDY1/

3 percent	5 percent	10 percent	14 percent	16 percent	21-23 percent	26 percent
Adobe	Chalk rock	Caliche	Coarse gravel	Fine sand	Dry gravel	Coarse sand
Boulders in clay	Clay and gravel	Cemented boulders	Cobbles and gravel	Heaving sand	Gravelly sand	Fine gravel
Cemented clay	Clayey sand	Cemented gravel	Boulders	Quicksand	Loose gravel	Medium sand
Clay	Clayey silt	Cemented sand	Broken rocks	Sand and boulders	Medium gravel	
Clayey loam	Conglomerate	Cemented sand and gravel	Gravel and boulders	Sand, gravel, and boulders	Sand	
Decomposed shale	Decomposed granite	Dead gravel	Heaving gravel	Tight sand	Water gravel	
Granite and clay	Gravelly clay	Dead sand	Heavy gravel			
Hard clay	Loam	Dirty pack sand	Large gravel			
Hardpan	Rotten conglomerate	Hard gravel	Muddy sand			
Hard sandy shale	Rotten granite	Hard sand	Rocks			
Hard shell	Sand and clay	Heavy rocks	Sand and gravel, silty			
Muck	Sand and silt	Soft sandstone	Silty sand			
Shale	Sand rock	Tight boulders	Tight fine gravel			
Shaley clay	Sandstone	Tight coarse gravel	Tight medium gravel			
Shell rock	Sandy clay					
Silty clay loam	Sandy silt					
Soapstone	Sediment					
	Shaley gravel					
	Silt					
	Silty clay					
	Silty loam					
	Silty sand					
	Soil					

1/ Value of one added to given value where streaks of sand or gravel occur in clay or clayey material. Value of one subtracted from given value where streaks of clay occur in sand or gravel material.

From Table A, Attachment 2, Department of Water Resources Bulletin No. 104, "Planned Utilization of the Ground Water Basins of the Coastal Plain of Los Angeles County", Appendix A, "Ground Water Geology", June 1961.


JOINT STUDY
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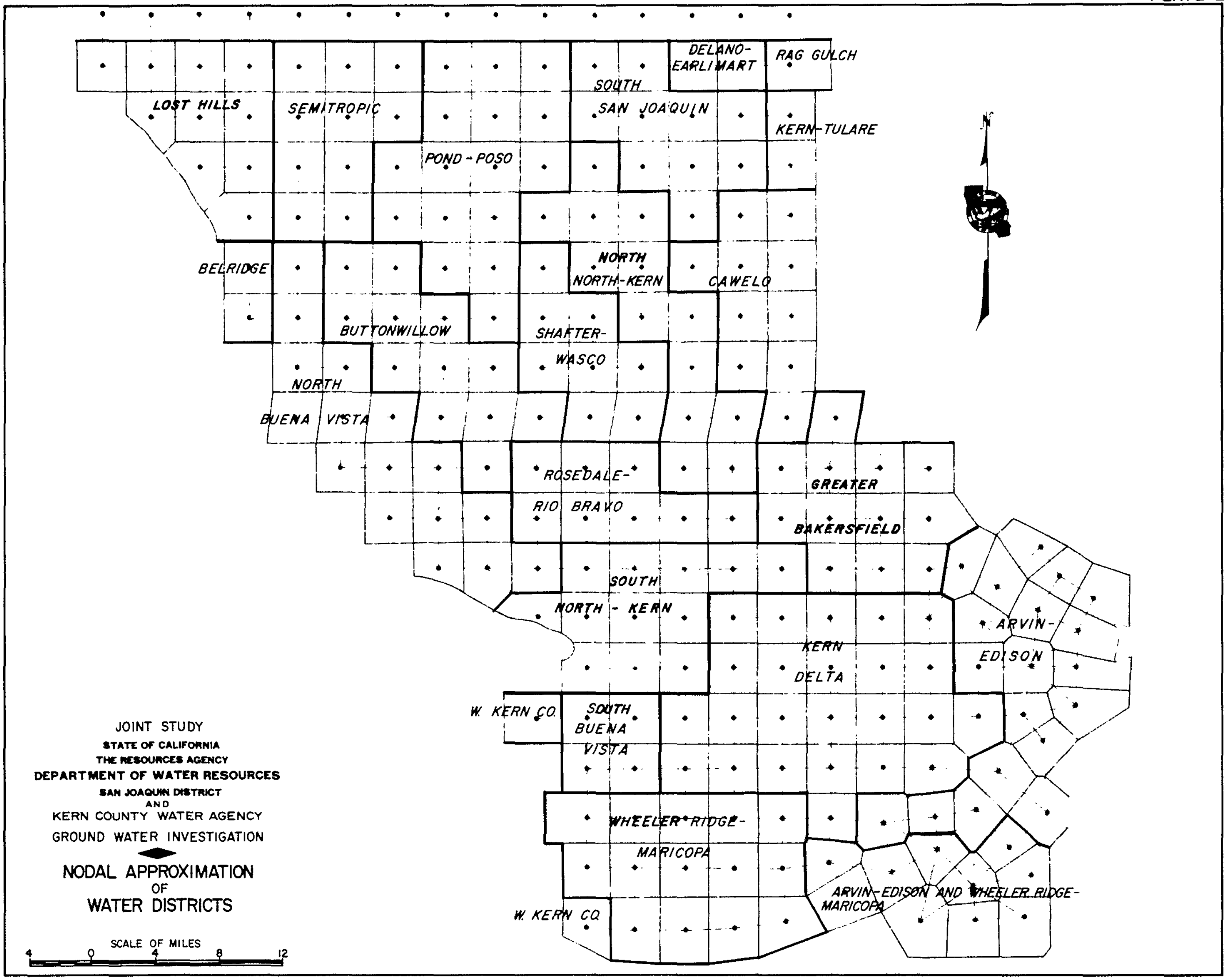
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SAN JOAQUIN DISTRICT
AND
KERN COUNTY WATER AGENCY
GROUND WATER INVESTIGATION
NODAL POLYGON NETWORK
SCALE OF MILES
4 0 4 8 12
UNCONFINED NODE NUMBER
CONFINED NODE NUMBER
BAKERSFIELD
KERN LAKE BED
BUENA VISTA LAKE BED
ELK HILLS
BUENA VISTA HILLS
SAN EMIGDIO MOUNTAINS
MARICOPA
TAFT
FORD CITY
DELANO
WHEELER RIDGE
GRAPEVINE
LAMONT
OILDALE
OIL CITY
KERN RIVER
BAKERSFIELD FAULT
WHITE WOLF FAULT
PLEITO FAULT
EDISON FAULT
BUENA VISTA PUMPING PLANT
WHEELER RIDGE PUMPING PLANT
TEHACHAPI PUMPING PLANT
T24S
T25S
T26S
T27S
T28S
T29S
T30S
T31S
T32S
T12N
T11N
T10N
R17E
R18E
R19E
R20E
R21E
R22E
R23E
R24E
R25E
R26E
R27E
R28E
R29E
R30E
R24W
R23W
R22W
R21W
R20W
R19W
R18W
KINGS COUNTY
KERN COUNTY
TULARE COUNTY

C—040783

PLATE 2


LOST HILLS
SEMITROPIC
POND - POSO
SOUTH
SAN JOAQUIN
DELANO-
EARLIMART
RAG GULCH
KERN-TULARE
BELRIDGE
NORTH
NORTH-KERN
CAWELO
BUTTONWILLOW
SHAFTER-
WASCO
NORTH
BUENA VISTA
ROSEDALE-
RIO BRAVO
GREATER
BAKERSFIELD
SOUTH
NORTH - KERN
KERN
DELTA
ARVIN-
EDISON
W. KERN CO.
SOUTH
BUENA
VISTA
WHEELER RIDGE-
MARICOPA
W. KERN CO.
ARVIN-EDISON AND WHEELER RIDGE-
MARICOPA
JOINT STUDY
STATE OF CALIFORNIA
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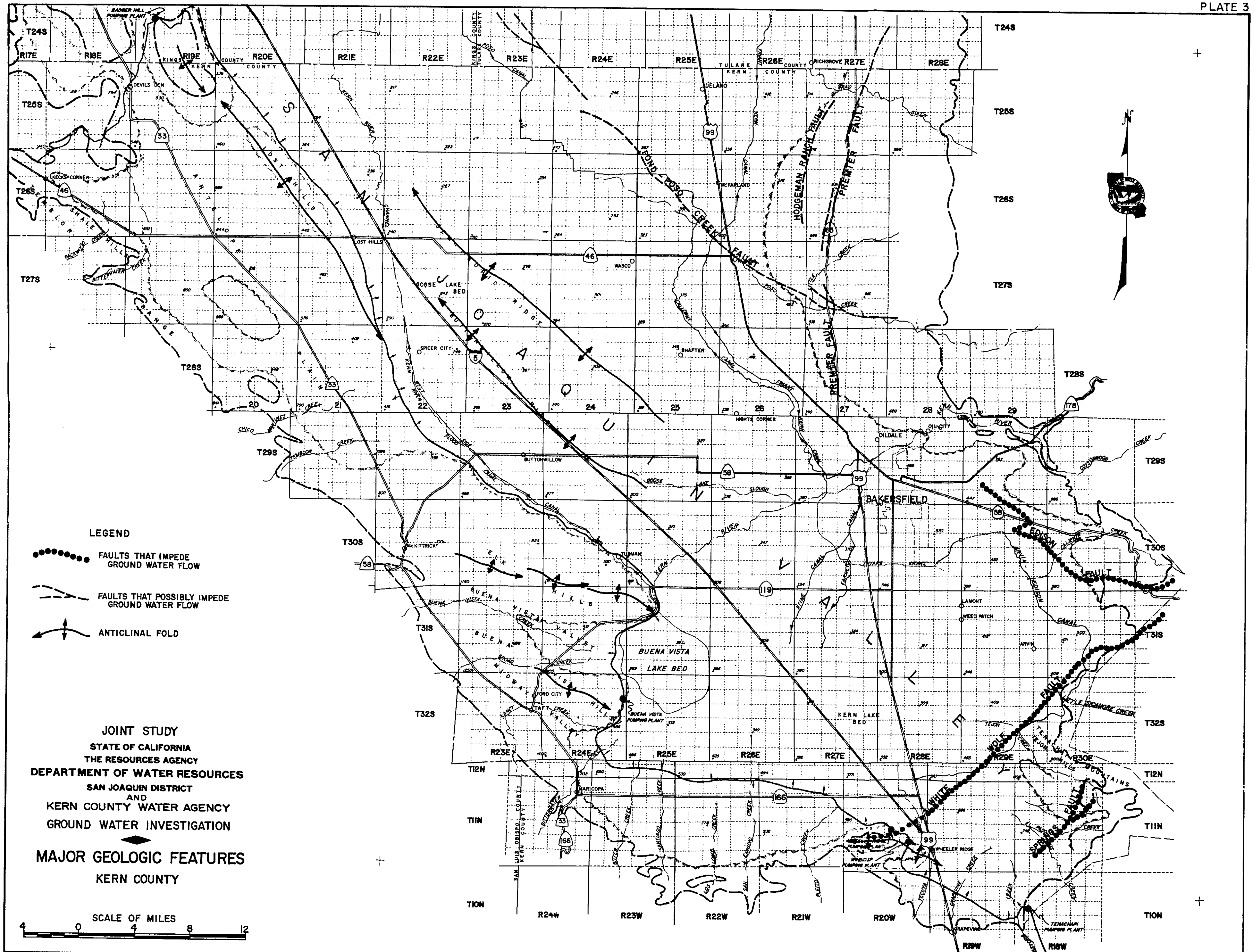
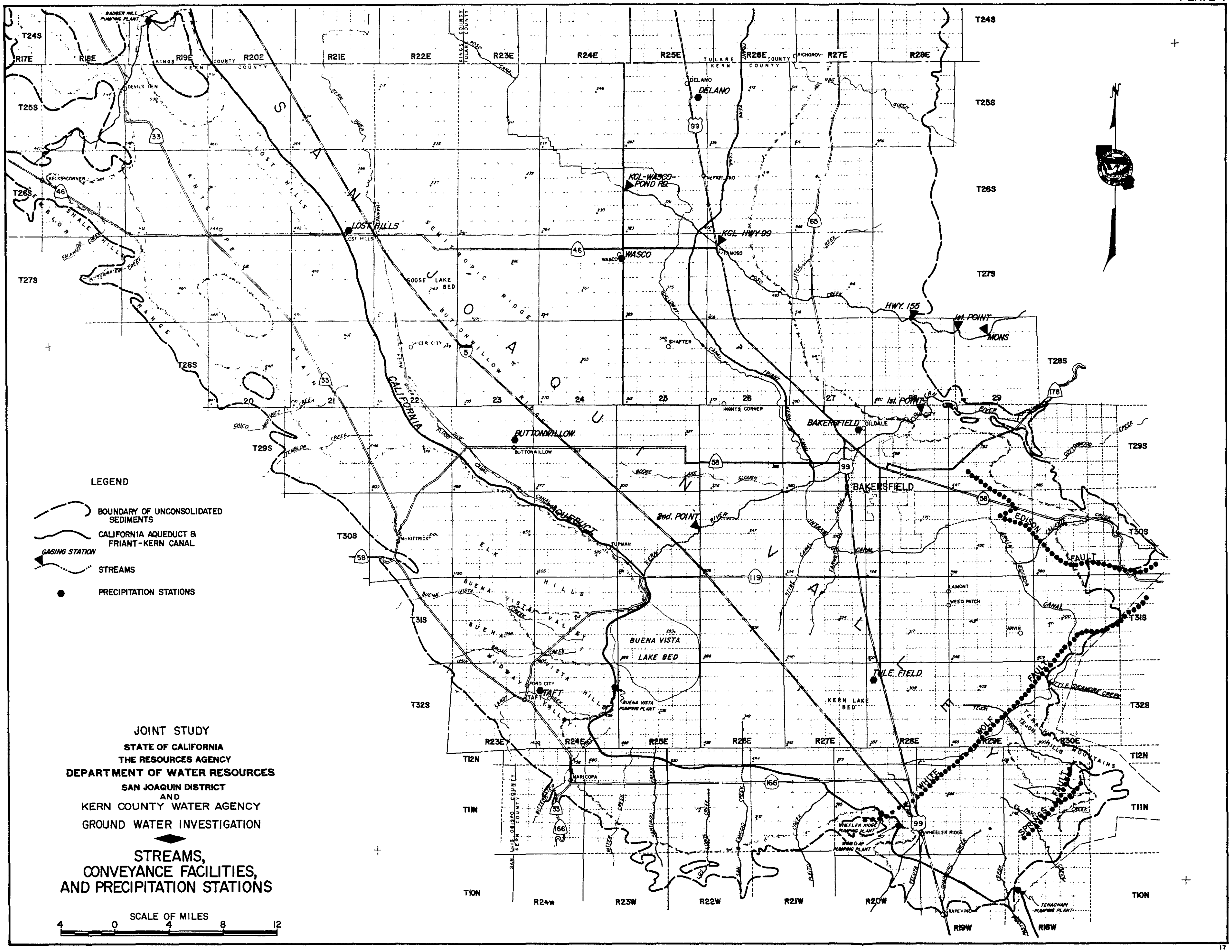
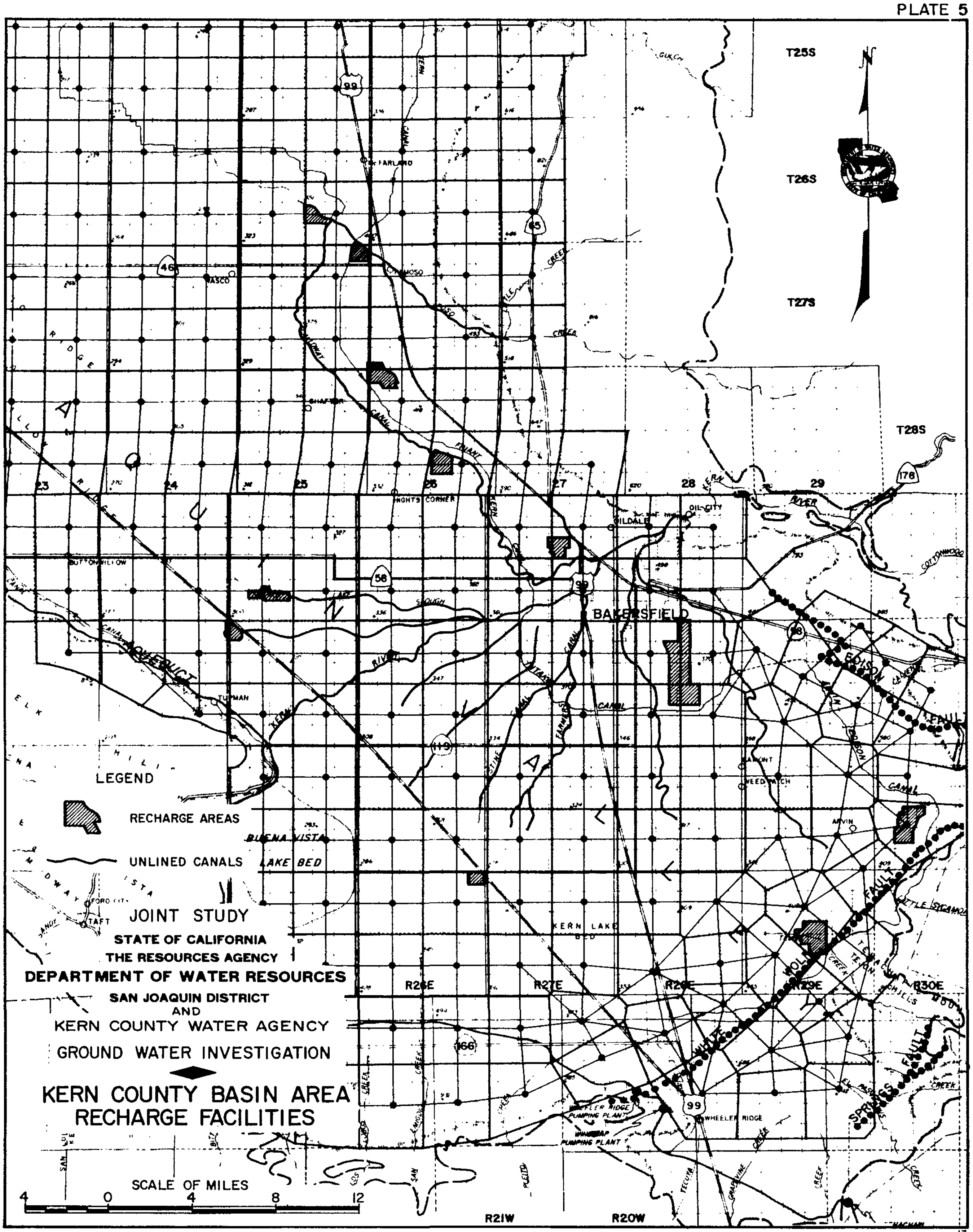
DEPARTMENT OF WATER RESOURCES
SAN JOAQUIN DISTRICT
AND
KERN COUNTY WATER AGENCY
GROUND WATER INVESTIGATION
NODAL APPROXIMATION
OF
WATER DISTRICTS
SCALE OF MILES
4 0 4 8 12


LEGEND
FAULTS THAT IMPEDE GROUND WATER FLOW
FAULTS THAT POSSIBLY IMPEDE GROUND WATER FLOW
ANTICLINAL FOLD
JOINT STUDY
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SAN JOAQUIN DISTRICT
AND
KERN COUNTY WATER AGENCY
GROUND WATER INVESTIGATION
MAJOR GEOLOGIC FEATURES
KERN COUNTY
SCALE OF MILES
4 0 4 8 12
SAN JOAQUIN VALLEY
BAKERSFIELD
DELANO
McFARLAND
WASCO
SHAFTER
LOST HILLS
BUTTONWILLOW
OILDALE
LAMONT
WEED PATCH
ARVIN
TAFT
FORD CITY
MARICOPA
McKITTRICK
DEVILS DEN
SPICER CITY
WHEELER RIDGE
RAPEVINE
BUENA VISTA LAKE BED
KERN LAKE BED
GOOSE LAKE BED
POND-POSO CREEK FAULT
HODGEMAN RANCH FAULT
PREMIER FAULT
EDISON FAULT
WHITE WOLF FAULT
SPRINGS FAULT
ELK HILLS
BUENA VISTA HILLS
LOST HILLS
KERN RIVER
TEHACHAPI MOUNTAINS
T24S
T25S
T26S
T27S
T28S
T29S
T30S
T31S
T32S
T12N
T11N
T10N
R17E
R18E
R19E
R20E
R21E
R22E
R23E
R24E
R25E
R26E
R27E
R28E
R29E
R30E
R24W
R23W
R22W
R21W
R20W
R19W
R18W

C-040786



C — 0 4 0 7 8 6


LEGEND
RECHARGE AREAS
UNLINED CANALS
JOINT STUDY
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SAN JOAQUIN DISTRICT
AND
KERN COUNTY WATER AGENCY
GROUND WATER INVESTIGATION
KERN COUNTY BASIN AREA
RECHARGE FACILITIES
SCALE OF MILES
4 0 4 8 12
T25S
T26S
T27S
T28S
R26E
R27E
R28E
R29E
R30E
R21W
R20W
BAKERSFIELD
OILDALE
OIL CITY
McFARLAND
WASCO
SHAFTER
FAMOSO
BUTTONWILLOW
TUPMAN
ARVIN
WEEDPATCH
LAMONT
TAFT
WHEELER RIDGE
WHEELER RIDGE PUMPING PLANT
WIND GAP PUMPING PLANT
BUENA VISTA
LAKE BED
KERN LAKE BED
EDISON
FRIANT
CANAL
AQUEDUCT
KERN
RIVER
SLOUGH
99
46
65
58
119
166
178

C-040787

PLATE 6

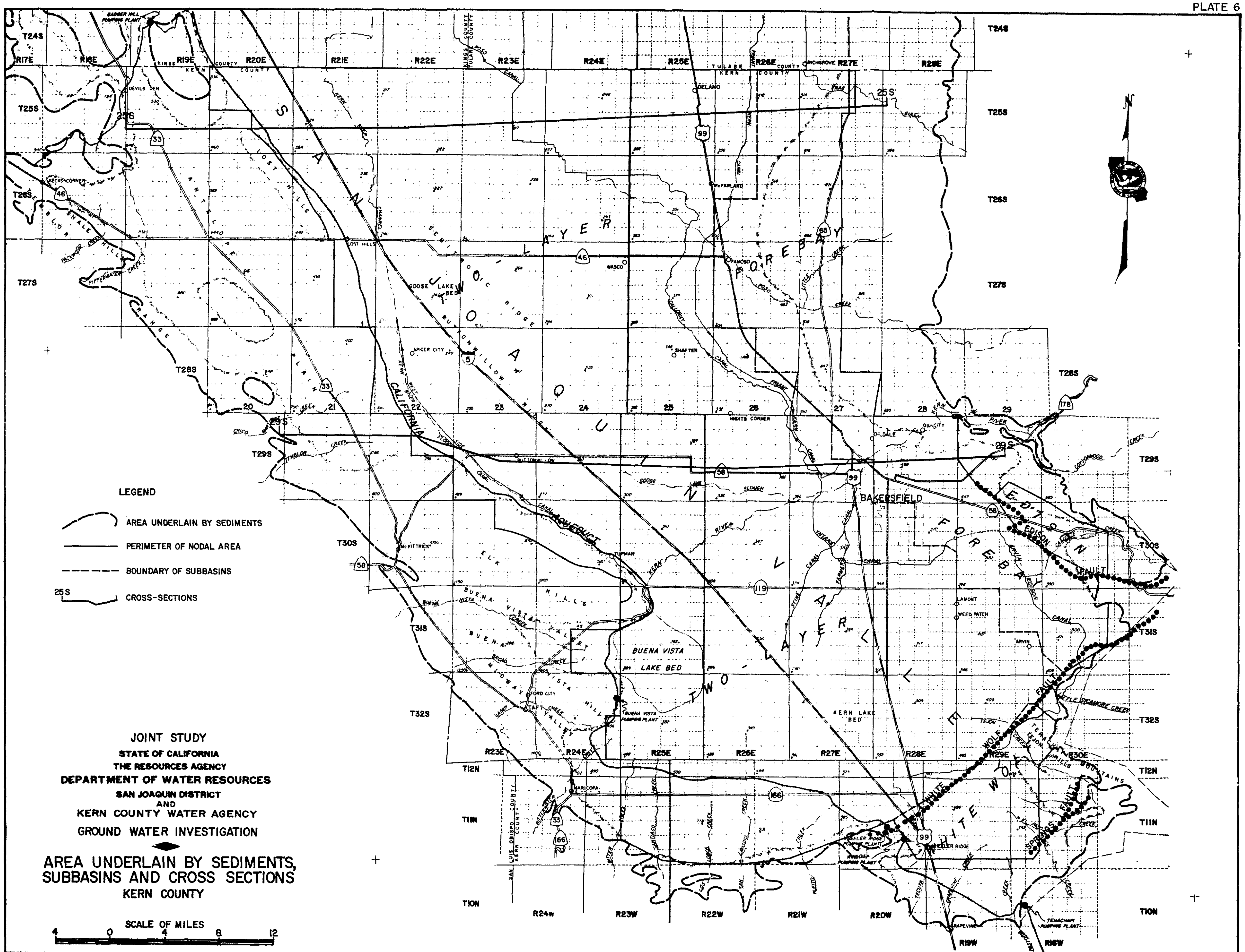
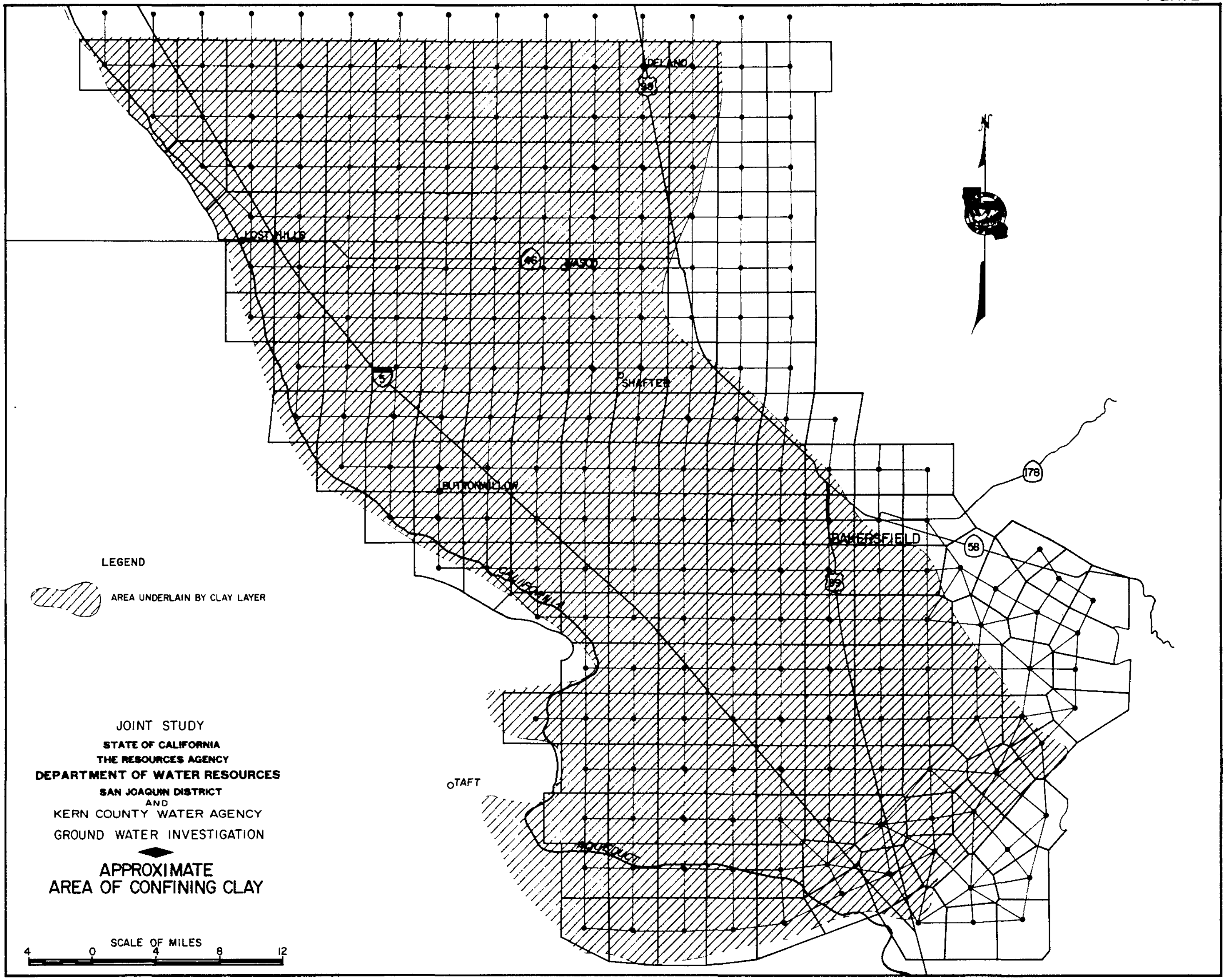

LEGEND
AREA UNDERLAIN BY SEDIMENTS
PERIMETER OF NODAL AREA
BOUNDARY OF SUBBASINS
25S
CROSS-SECTIONS
JOINT STUDY
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SAN JOAQUIN DISTRICT
AND
KERN COUNTY WATER AGENCY
GROUND WATER INVESTIGATION
AREA UNDERLAIN BY SEDIMENTS,
SUBBASINS AND CROSS SECTIONS
KERN COUNTY
SCALE OF MILES
4 0 4 8 12
SAN JOAQUIN VALLEY
ONE LAYER
TWO LAYER
FOREBAY
BAKERSFIELD
DELANO
McFARLAND
WASCO
SHAFTER
BUENA VISTA LAKE BED
KERN LAKE BED
GOOSE LAKE BED
ELK HILLS
BUENA VISTA HILLS
CALIFORNIA AQUEDUCT
EDISON FAULT
WHITE WOLF FAULT
MARICOPA
TAFT
McKITTRICK
LOST HILLS
ARVIN
LAMONT
WEED PATCH
TEHACHAPI PUMPING PLANT
BUENA VISTA PUMPING PLANT
WHEELER RIDGE PUMPING PLANT
WIND GAP PUMPING PLANT
WHEELER RIDGE
BADGER HILL PUMPING PLANT
DEVILS DEN
KECKS CORNER
SPICER CITY
OILDALE
OIL CITY
TUPMAN
FORD CITY
GRAPEVINE
KERN RIVER
POSO CREEK
T24S
T25S
T26S
T27S
T28S
T29S
T30S
T31S
T32S
T12N
T11N
T10N
R17E
R18E
R19E
R20E
R21E
R22E
R23E
R24E
R25E
R26E
R27E
R28E
R29E
R30E
R24W
R23W
R22W
R21W
R20W
R19W
R18W

PLATE 7


DELANO
99
LOST HILLS
46
WASCO
5
SHAFTER
BUTTONWILLOW
178
BAKERSFIELD
58
99
CALIFORNIA
AQUEDUCT
TAFT
LEGEND
AREA UNDERLAIN BY CLAY LAYER
JOINT STUDY
STATE OF CALIFORNIA
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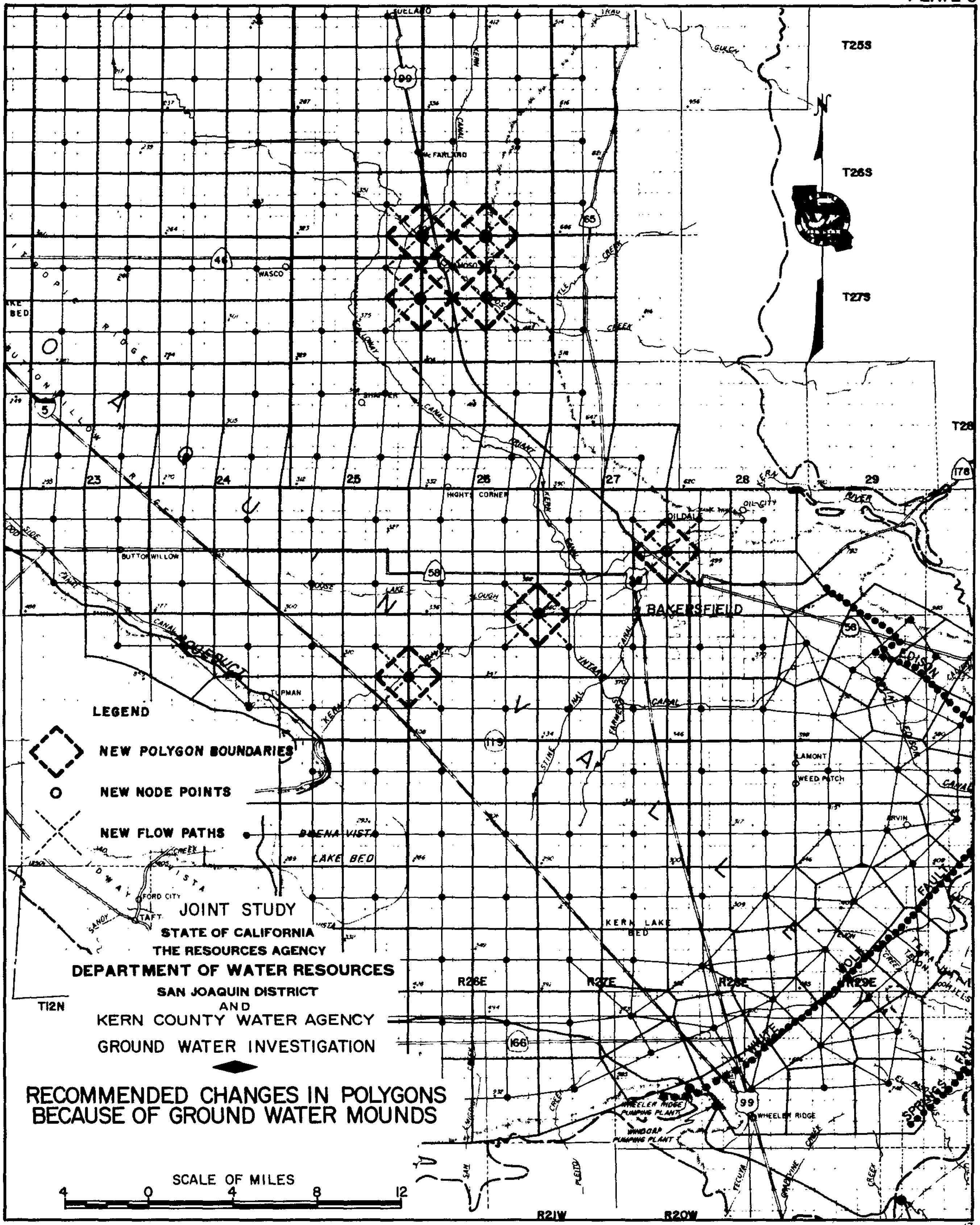
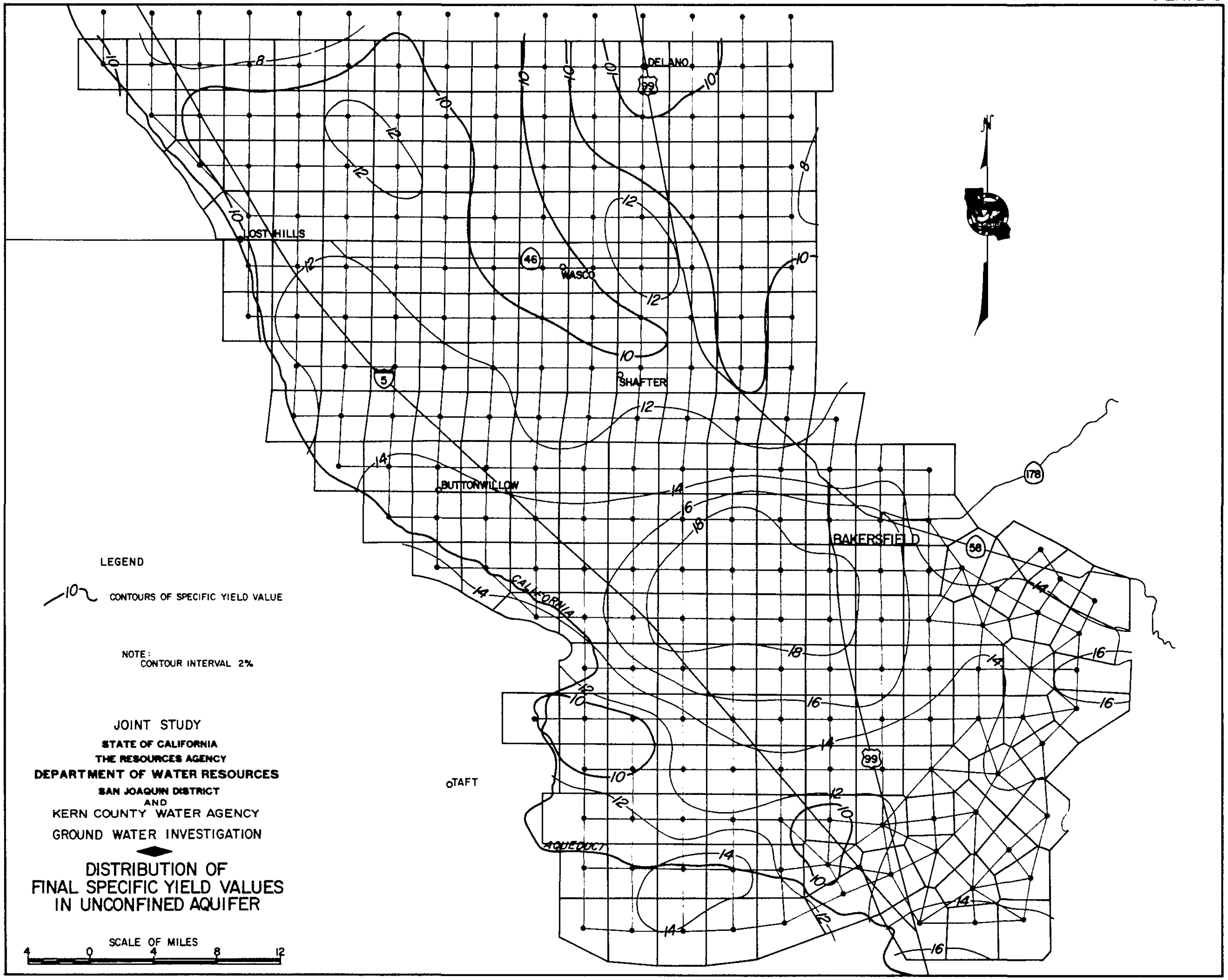
DEPARTMENT OF WATER RESOURCES
SAN JOAQUIN DISTRICT
AND
KERN COUNTY WATER AGENCY
GROUND WATER INVESTIGATION
APPROXIMATE
AREA OF CONFINING CLAY
SCALE OF MILES
4 0 4 8 12



RECOMMENDED CHANGES IN POLYGONS BECAUSE OF GROUND WATER MOUNDS

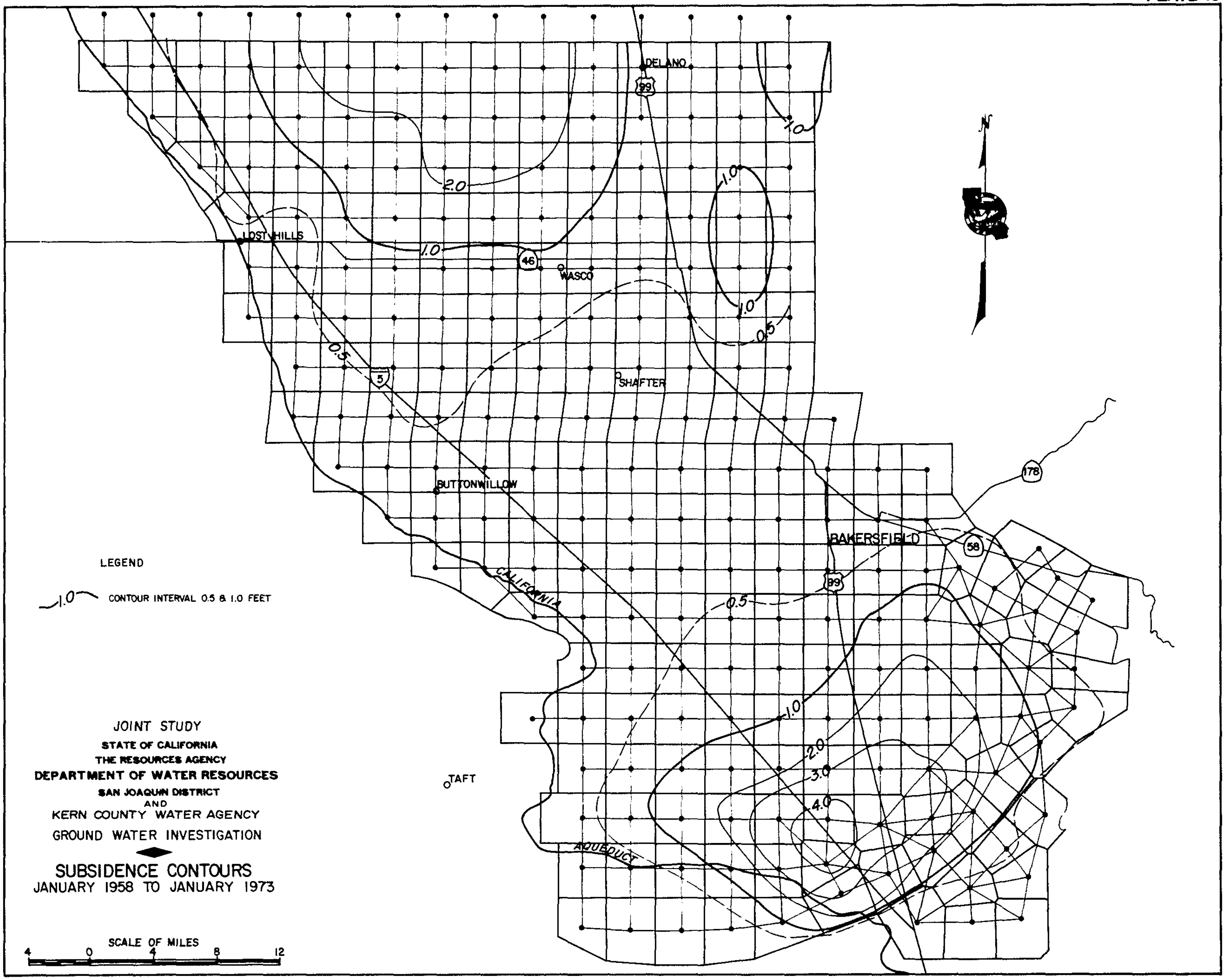
C-040791

PLATE 9



C-040791

PLATE 10



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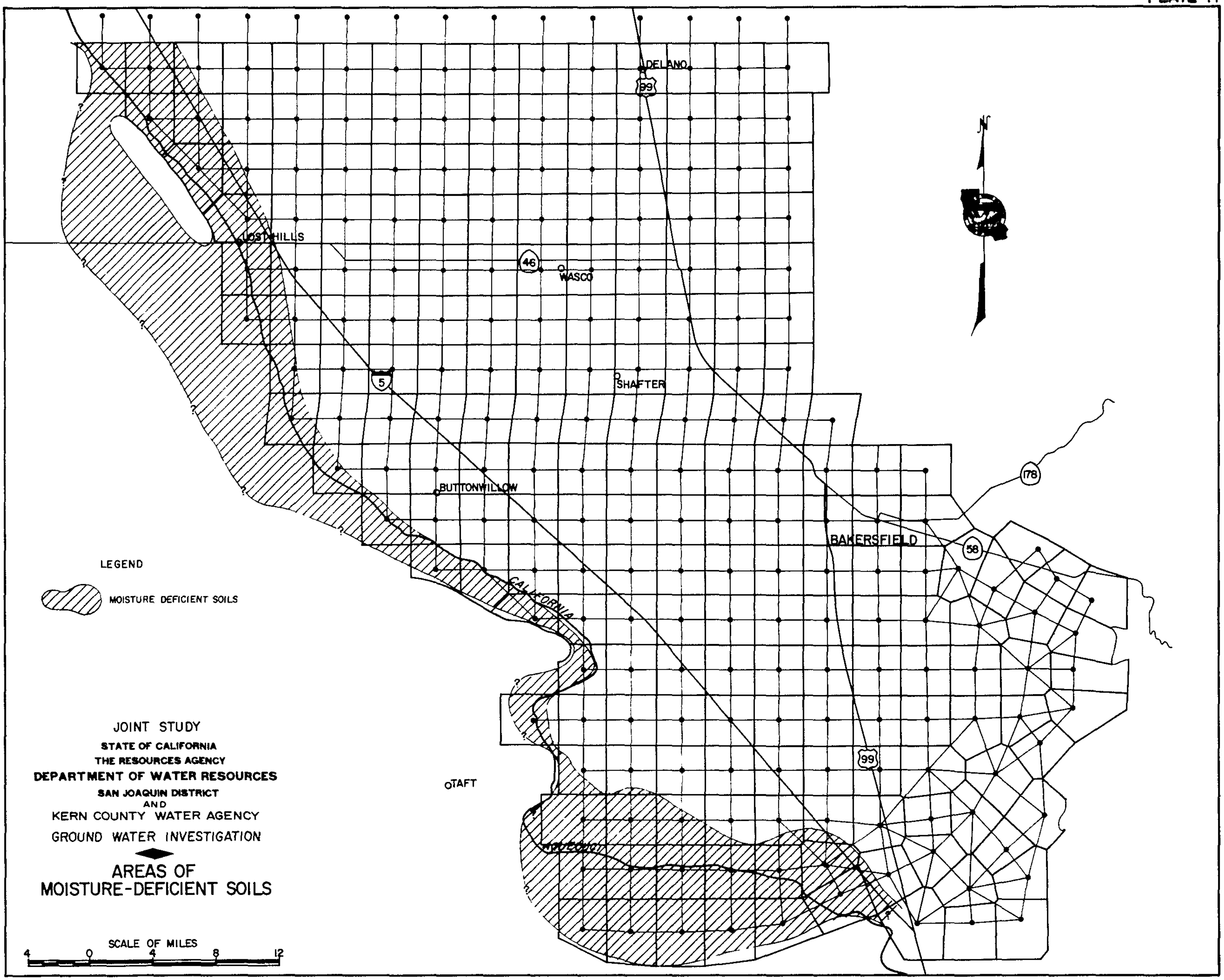
GROUND WATER INVESTIGATION

SUBSIDENCE CONTOURS
JANUARY 1958 TO JANUARY 1973

C-040792

C-040792



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AND
KERN COUNTY WATER AGENCY
GROUND WATER INVESTIGATION

AREAS OF
MOISTURE-DEFICIENT SOILS